CHAPTER 2

MASONRY

2-1 CONCRETE HOLLOW BLOCKS

Concrete Hollow Block is popularly known as CHB. It is classified as load bearing and non-bearing blocks. Load bearing blocks are those whose thickness ranges from 15 to 20 centimeters and are used to carry load aside from its own weight.

Non-bearing blocks on the other hand, are blocks intended for walls, partitions, fences, dividers and the like carrying its own weight whose thickness ranges from 7 to 10 centimeters.

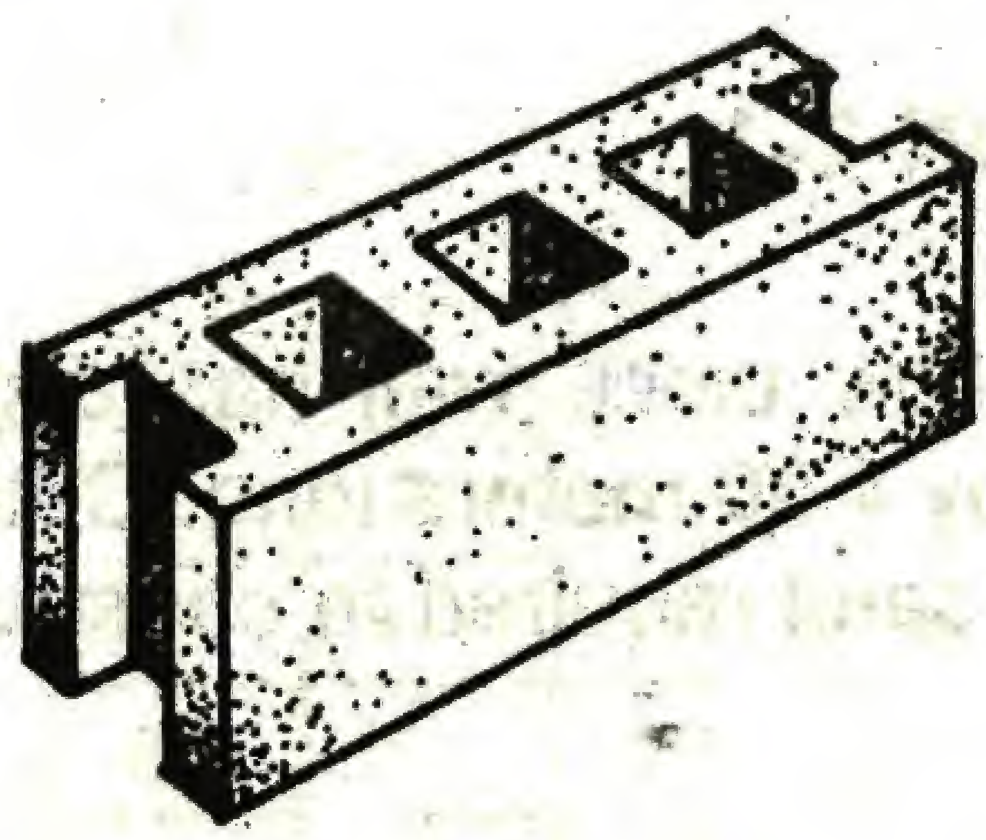


FIGURE 2-1 CONCRETE HOLLOW BLOCK

The standard hollow blocks has three void cells and two half cells at both ends having a total of four. These hollow cells vary in sizes as there are different manufacturers using different types of mold. Hence, it is recommended that concrete hollow blocks with bigger cells be considered in estimating for a more realistic result.

In this study, what we want to know is the quantity of the materials needed for a certain masonry work made of concrete.

hollow bloc! which generally comprises of the following items.

1. Concrete hollow blocks.
2. Cement and sand for block laying.
3. Cement, sand and gravel filler for the hollow core or cell.
4. Cement and fine sand for plastering.
5. Cement sand and gravel for foundation or footing.
6. Reinforcing steel bars and
7. Tie wires.

Item 1 to 5 will be discussed in this chapter. The reinforcing steel bars and Tie wires will be presented in Chapter 3 -Metal Reinforcement.

Estimating the materials for masonry work using hollow blocks, could be done in either of the following methods:

By Fundamental methods
By the Area methods

ILLUSTRATION 2-1

A concrete hollow block wall has a general dimension of 3.00 meters high by 4.00 meters long. Determine the number of CHB, cement and sand required to construct the wall.

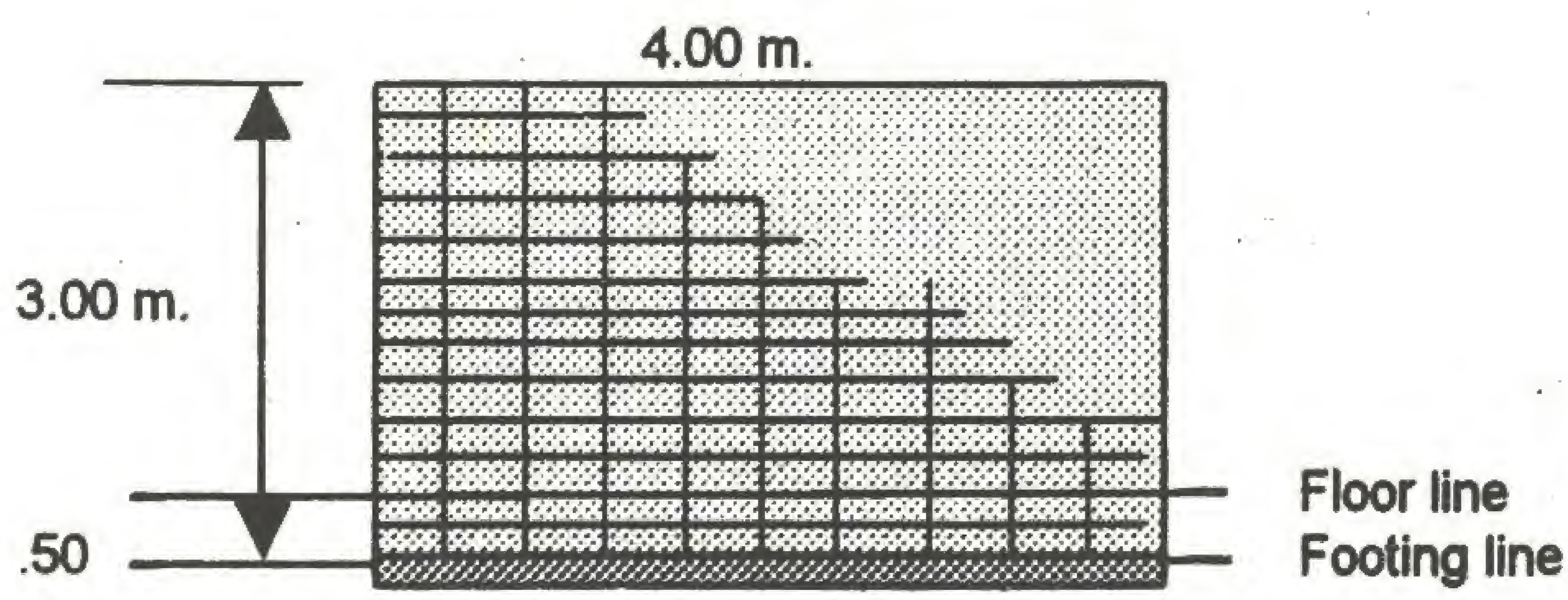


FIGURE 2-2 CONCRETE HOLLOW BLOCKS WALL

SOLUTION - 1 (By Fundamental Method)

1. Divide the height of the fence by the height of one block.

   $\frac{3.00}{.20} =$ 15 layers

2. Divide the length of the fence by the length of one block

   $\frac{4.00}{.40} =$ 10 pieces

3. Multiply the result of step 1 by step 2

   15 x 10 = 150 pieces

SOLUTION – 2 (By the Area Method)

Let us examine first how many pieces of CHB can cover up one square meter area.

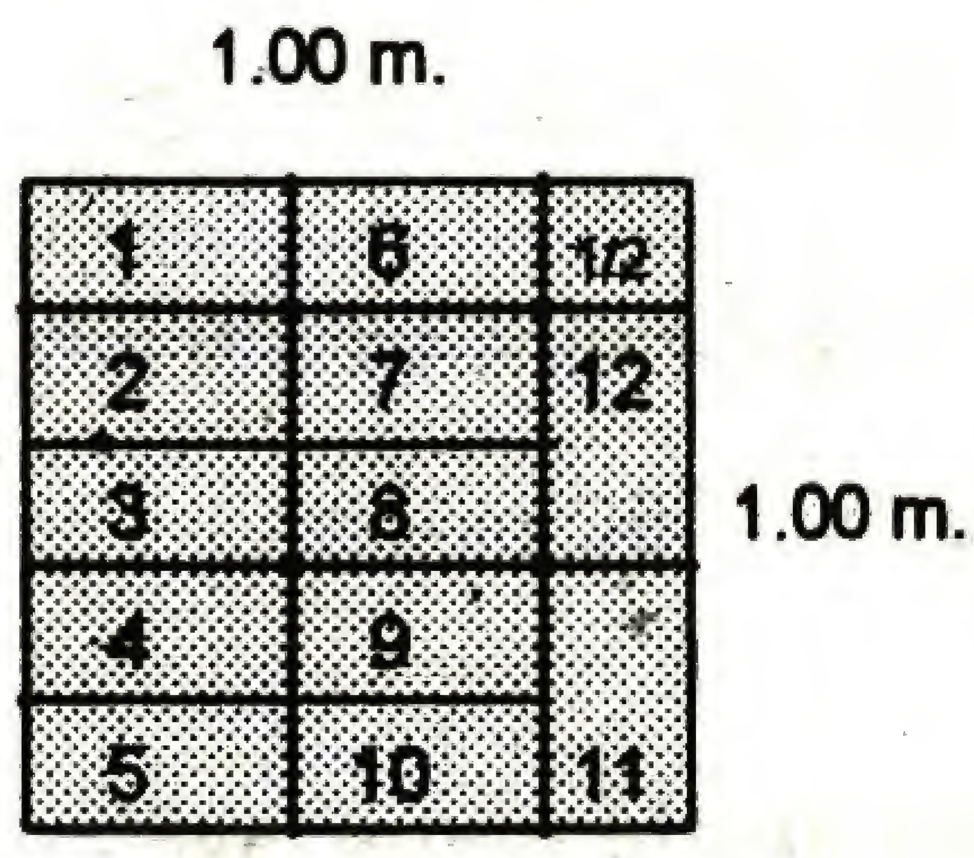


FIGURE 2-3 NUMBER OF CHB PER SQUARE METER

From the above figure it appears, that one square meter area requires 12.5 pieces concrete hollow blocks. Therefore, by multiplying the entire area of the wall by 12.5, we find the total number of CHB required. Thus,

1. Area of the fence; 3.00 x 4.00 m = 12 sq. m.

2. Multiply : 12.00 sq. m. x 12.5 = 150 pieces.

ILLUSTRATION 2-2

From the following Figure 2-4, find the number of 4" x 8" x 16" concrete hollow blocks to construct the fence.

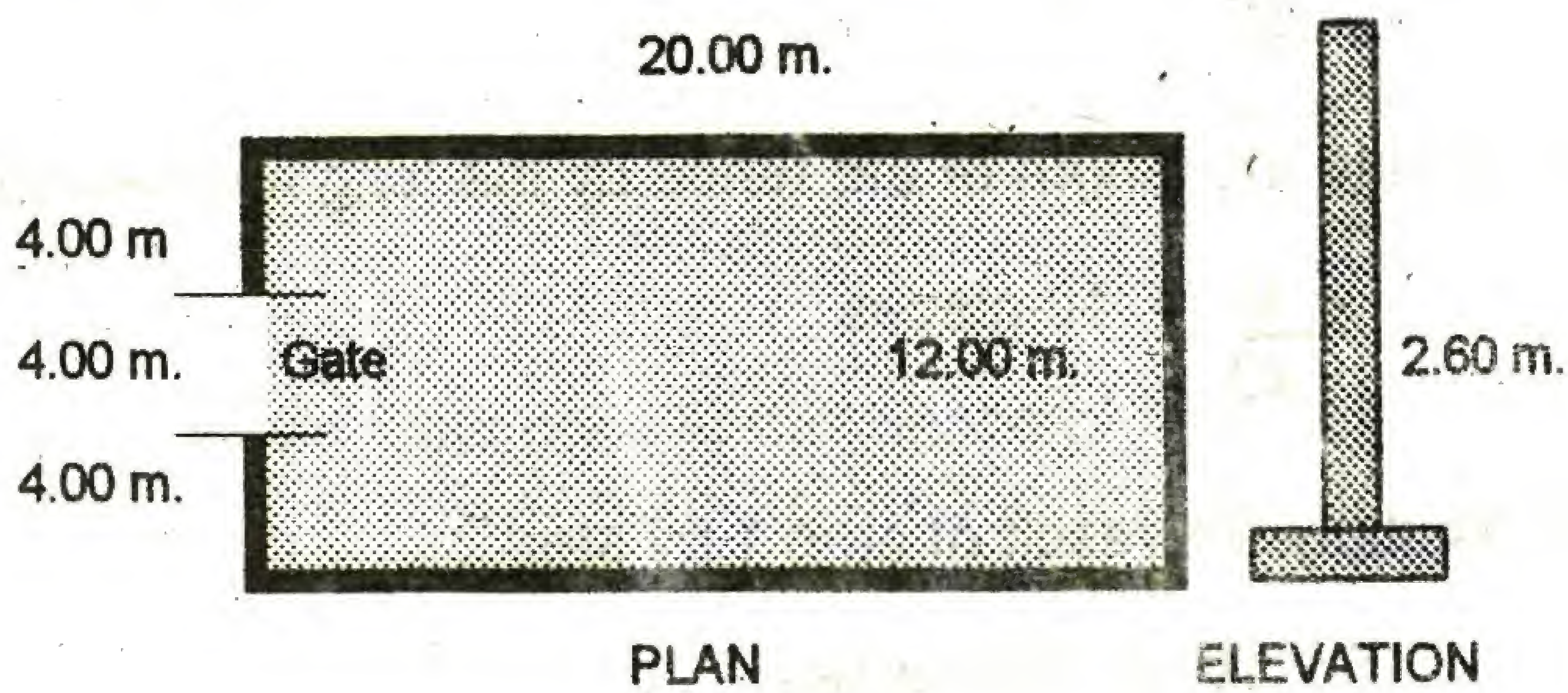


FIGURE 2-4 CHB FENCE

SOLUTION - 1 (By Fundamental Method)

1. Find the Perimeter of the Fence

   P = 4 + 4 + 12 + 20 + 20 = 60.00 meters.

2. Divide this perimeter by the length of one block

   $$\frac{60.00}{.40} = 150 \text{ pieces}$$

3. Divide the height of the wall by the height of one block

   $$\frac{2.60}{.20} = 13 \text{ layers}$$

4. Multiply 2 and 3: 150 x 13 = 1,950 pieces.

SOLUTION - 2 (By the Area Method)

1. Find the area of the wall.

   A = 2.60 x 60.00 m. = 156 square meters.

2. If there are 12.5 blocks in one square meter then, multiply by the area.

   156 x 12.5 = 1,950 pieces.

Comments

1. Comparing the results obtained by the two methods, the answers are practically the same, but for convenience, the solution by the area method is much favored for being simple and direct to the answer.

2. Take note that in the above example, we computed the number of hollow blocks without posts. Suppose that Figure 2-4 was provided with the necessary posts as indicated in Figure 2-5, in this case, the area covered by the post will be subtracted from the total area of the wall, then solve for the CHB adopting the area method for simplicity of the process.

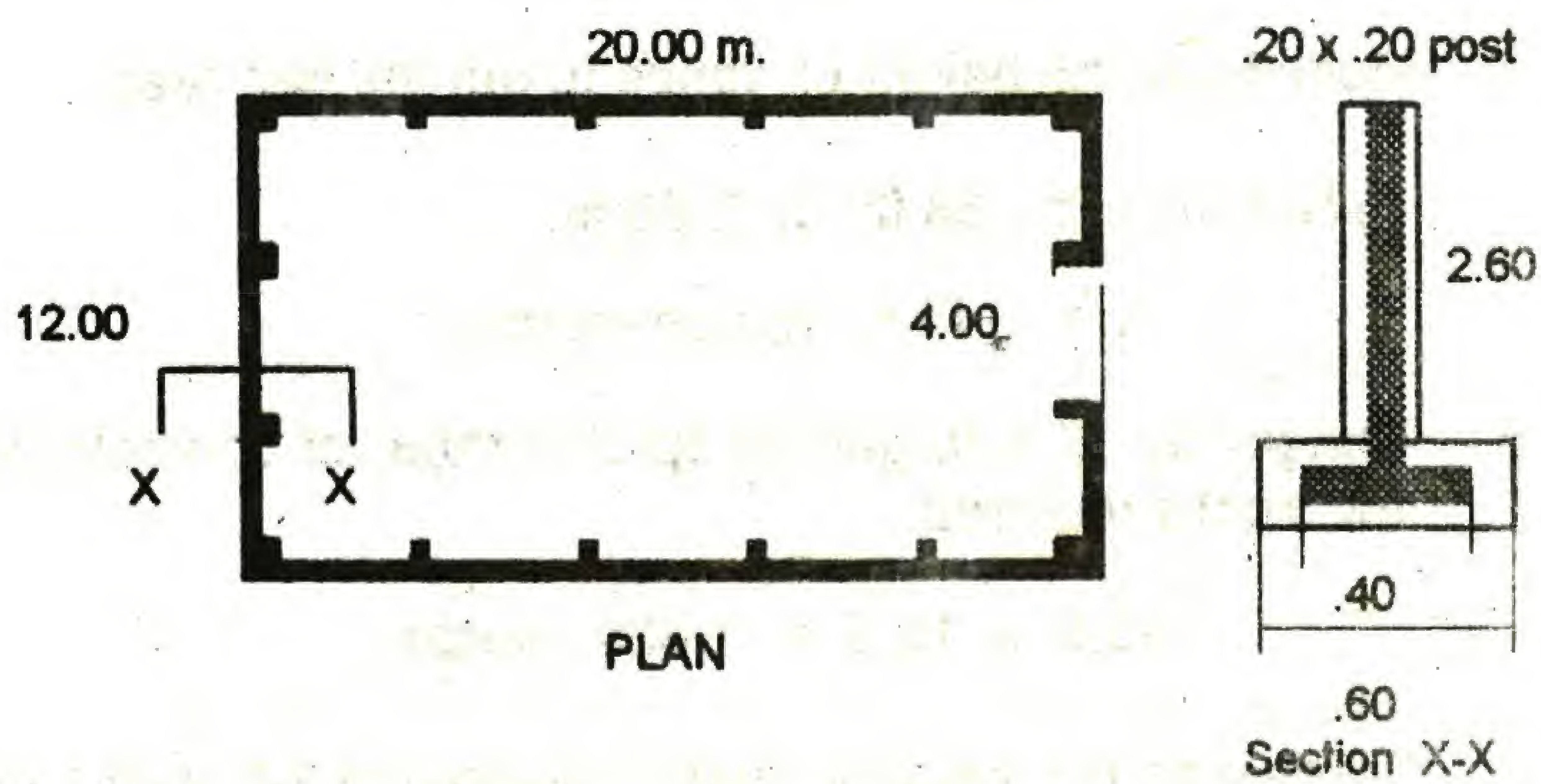


FIGURE 2-5 CHB FENCE

ILLUSTRATION 2-3

From Figure 2-5, using class B mixture find the number of:

a) 10 x 20 x 40 cm. concrete hollow blocks

b) Cement and sand.
c) Concrete for the posts and footings.

SOLUTION – 1 (Finding the CHB)

1. Find the perimeter of the wall.

   P = 20 + 20 + 12 + 8
   P = 60.00 meters

2. Find the space length occupied by the posts

Along 20 m. (.20 x 6) 2	=	2.40
Along 12 m. (.20 x 4) 2	=	1.60
Total space occupied by posts	=	4.00

3. Subtract: 60.00 m. – 4.00 m.

   = 56.00 m. net length for CHB.

5. Multiply by the height of fence to get the Net Area.

   Net Area = 56.00 x 2.60 ht.
   A = 145.6 square meters

6. Multiply by 12.5 to get the total number of concrete hollow blocks required.

   145.6 x 12.5 = 1,820 pieces.

7. Comparing this result to that of illustration 2-2, with 1,950 pieces hollow blocks, there is a material difference of 130 pieces because we subtracted the space occupied by the concrete posts.

SOLUTION– 2 (Concrete Posts and its Footing)

1. Find the volume of one concrete footing slab.

Volume = Thickness x Width x Length

V = .15 x .60 x .60
V = .054 cu. m.

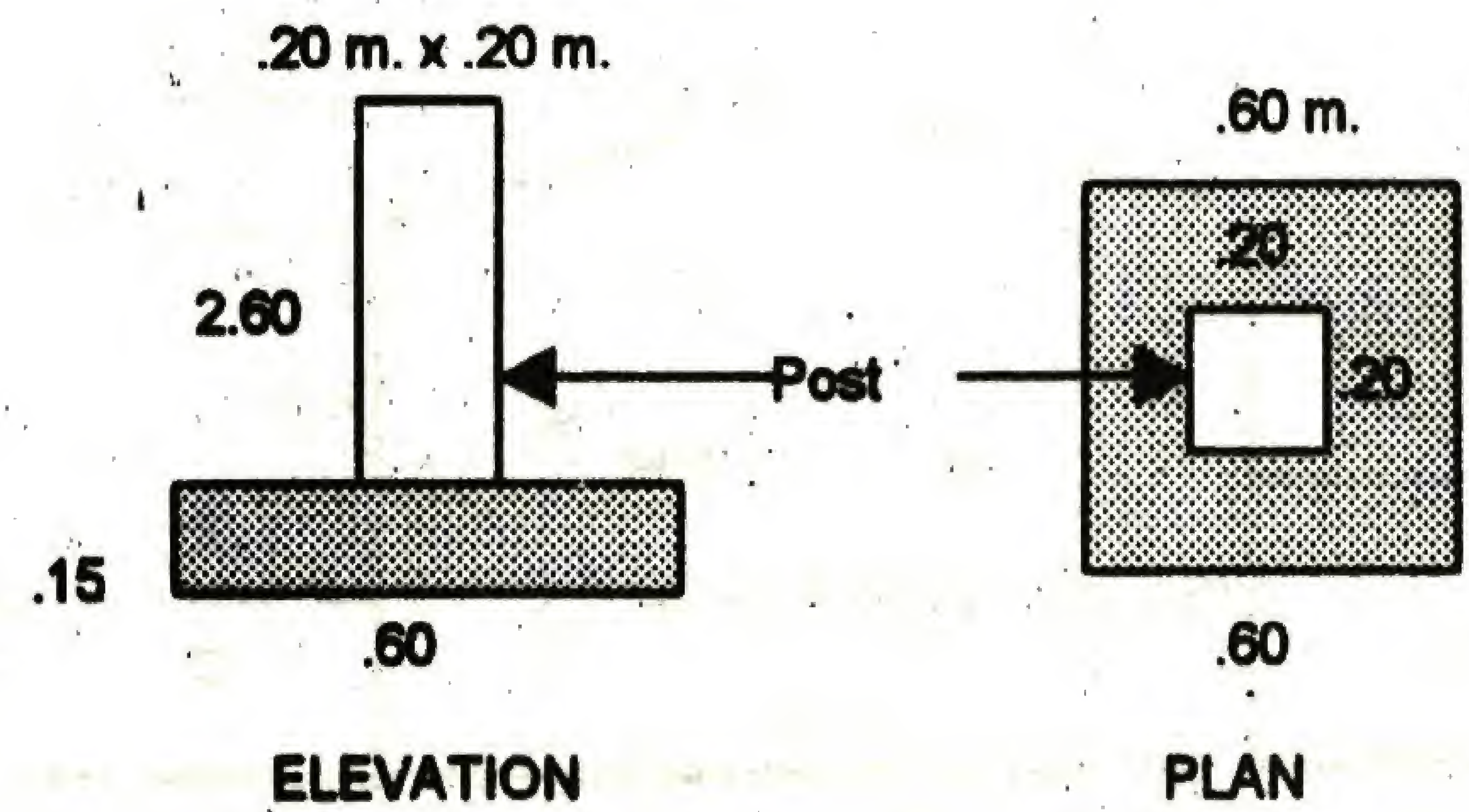


FIGURE 2-6 POST AND FOOTING

2. Find the volume of 16 footings

   V = (.054 x 16) = .864 cu. m.

3. Find the volume of 16 concrete posts

   V = (.20 x .20 x 2.60 x 16) = 1.67 cu. m.

4. Total volume of concrete posts and its footing:
   Add results of step 2 and 3:

   V_t; .864 + 1.67 = 2.53 cu. m.

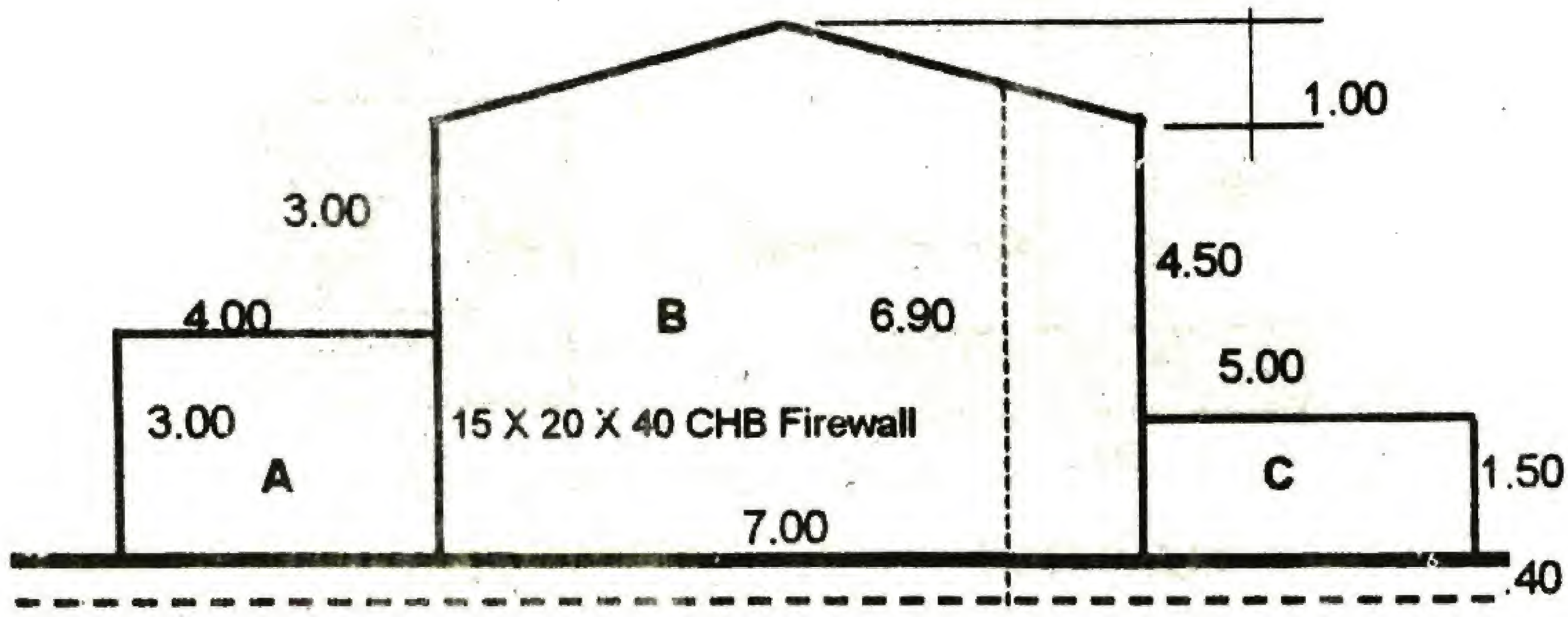
5. Refer to Table 1-2. Using class "B" concrete under column 40 kg. cement, multiply:

   Cement : 2.53 x 7.5 = 19.0 bags
   Sand : 2.53 x .50 = 1.26 cu. m.
   Gravel : 2.53 x 1.0 = 2.53 cu. m.

*** Note:**
Concrete was thoroughly discussed in Chapter - 1

ILLUSTRATION 2-4

From the following Figure, determine the number of 15 x 20 x 40 cm. CHB required to construct the building firewall.



ELEVATION

FIGURE 2-7 15 CHB FIREWALL

SOLUTION (By Direct Counting)

1. Find the CHB at **Area A :** $\frac{4.00}{.40}$ = 10 pieces

2. Height of wall A divided by height of one block

   $\frac{3.40}{.20}$ = 17 pieces

3. Multiply: (1) and (2) : 10 x 17 = 170 pieces

4. Find the CHB at **Area B :** $\frac{7.00}{.40}$ = 17.5

5. Average Height of Area B divided by .20 ht. of one block

   $\frac{6.90}{.20}$ = 34.50

6. Multiply (4) and (5) : 17.5 x 34.50 = 603.75 pieces

7. Find the CHB at Area **C** : $\frac{5.00}{.40} = 12.50$

8. Height of C divided by height of one block

$$\frac{1.90}{.20} = 9.50$$

9. Multiply (7) and (8) 12.50 x 9.50 = 118.75 pieces

Add Total CHB for Area A, B and C.

170 + 603.75 + 118.75 = 893 pieces

Comment:

Take note that in the preceding example solution, fundamental methods of determining the number of blocks were used. The methods had undergone a very long process of finding the quantity by area one at a time. The process must be simplified with the aid of Table 2-2, presented as follows:

SOLUTION - 2 (By the Area Method)

1. Find the Area of A: 3.40 x 4.00 = 13.60 sq. m.
2. Find the Area of B: 7.00 x 6.90 = 48.30 sq. m.
3. Find the Area of C: 5.00 x 1.90 = 9.50 sq. m.

Total Area -------- 71.40 sq. m.

4. Refer to Table 2-2. Along 15 x 20 x 40 CHB under column number per square meter; multiply:

71.40 x 12.50 = 893 pieces.

Reminder

Before estimating the quantity of concrete hollow blocks, be

sure to verify the plan specially the clear height of the wall which is very important in the process. The following questions should be given due consideration for these might affect the result of the estimate.

1. Does the elevation as indicated in the plan specify the height from the first floor to the second floor line, or is it from floor to ceiling? In either case, the depth of the beam has to be considered in the estimate, either added or subtracted.

2. Have you considered the CHB to be installed from the underground foundation to the floor line? This particular portion of the wall is often overlook in the process of estimating especially when there is no detailed plan or cross section detail. Don't ever commit the same mistake experienced by most estimators.

3. See to it that the concrete hollow blocks to be installed are uniform in sizes and in thickness. Have it ordered from one manufacturer or supplier only. Installing different sizes of CHB means additional expenses for cement plaster and labor. If several suppliers cannot be avoided, have their respective blocks installed in a particular phase of work.

2-2 ESTIMATING CEMENT MORTAR

After knowing the number of blocks needed for a particular masonry work, the next step is to find its work partner called cement mortar. Cement mortar is a mixture of cement, sand and water. It is used as bonding materials in installing masonry blocks and other various plastering work. In estimating cement mortar, one has to consider the following items.

a. The mortar to be used in between the layer of CHB.
b. The mortar filler for the hollow core or cell of the blocks. This filler could be pure mortar or mortar with gravel for economy.
c. Fine screened sand for plastering.

ILLUSTRATION 2-5

Continuing the problem of Illustration 2-1 Figure 2-2, determine how many bags of cement and sand needed to install the 150 pieces 10 x 20 x 40 cm. CHB using class "B" mortar.

There are three solutions offered in finding the cement mortar for concrete hollow blocks installation.

1. By volume method.
2. By the Area Method.
3. Per Hundred Block method.

SOLUTION – 1 (By Volume Method)

1. Determine the volume of mortar in between the layer of the blocks, adopting the 12 mm (½") or .012 meters uniform thickness of the mortar.

   Volume = Thickness x Width of CHB x Length

   V = .012 x .10 x 4.00 m.
   V = .0048 cubic meter

2. Take note that 3.00 meters high wall divided by .20 m. height of one block is = 15 layers. Thus, multiply:

   V = 15 layers x .0048
   V = .072 cu. m.

   This is the total volume of the mortar in between the 15 layers of concrete hollow blocks.

3. Aside from the cement mortar used in between block layers, there are 4 hollow cores or cells per block to be filled up with mortar. Find the volume per block.

   Volume = .05 x .075 x .20 x 4 cores
   V = .003 cu. m.

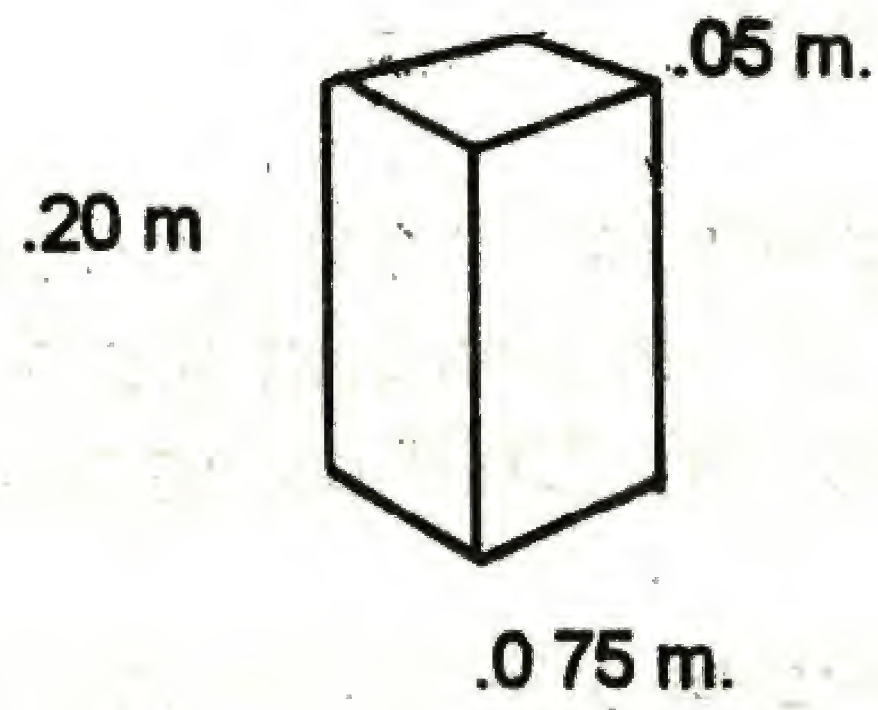


FIGURE 2- 8 HOLLOW CELL OF 4 x 8 x 16 CHB

4. Find the total volume of hollow core for the 150 CHB.

   V = 150 x .003 = .45 cu. m.

5. Total volume; add the results of step 2 and step 4.

   Total Volume : .072 + .45 = .522 cu. m.

6. Refer to Table 2-1. Using class "B" mixture, multiply:

   Cement : .522 x 12.0 = 6.26 bags
   Sand : .522 x 1.0 = .522

TABLE 2-1 QUANTITY OF CEMENT AND SAND FOR MORTAR AND PLASTER IN CUBIC METER

Class Mixture	Proportion	Cement in Bags		Sand
		40 kg.	50 kg.	cu. m.
A	1 : 2	18.0	14.5	1.0
B	1 ; 3	12.0	9.5	1.0
C	1 : 4	9.0	7.0	1.0
D	1 : 5	7.5	6.0	1.0

Another way of finding the mortar for block laying is by the Area Method with the aid of Table 2-2.

SOLUTION – 2 (By the Area Method)

1. Find the area of the wall.

Area : (3.00 x 4.00) = 12 square meters.

2. Refer to Table 2-2. Along 10 x 20 x 40 CHB under class "B" mixture; multiply:

Cement : 12 x .522 = 6.26 bags
Sand : 12 x .0435 = .522 cu. m.

TABLE 2-2 QUANTITY OF CEMENT AND SAND FOR CHB MORTAR PER SQUARE METER

Size of CHB in cm.	Number per sq. m	Bags Cement Mixture				
		A	B	C	D	Sand cu. m
10 x 20 x 40	12.5	.792	.522	.394	.328	.0435
15 x 20 x 40	12.5	1.526	1.018	.763	.633	.0844
20 x 20 x 40	12.5	2.260	1.500	1.125	.938	.1250

SOLUTION - 3 (By the Hundred Block Method)

The Hundred Block Method is the third solution offered for a more simpler approach with the aid of Table 2-3.

1. Find the number of concrete hollow blocks.

Area : 3.00 x 4.00 = 12 sq. m.
12 sq. m. x 12.5 = 150 pieces CHB

2. Convert to unit of 100: $\frac{150}{100} = 1.5$

3. Refer to Table 2-3. Under class "B" mixture for a 10 x 20 x 40 CHB, multiply:

Cement : 1.5 x 4.176 = 6.26 bags
Sand : 1.5 x .348 = .522 cu. m.

TABLE 2-3 QUANTITY OF CEMENT AND SAND PER ONE HUNDRED BLOCKS

Size of CHB	Cement in Bags 40 kg. Mixture				Sand cu. m.
	A	B	C	D	
10 x 20 x 40	6.336	4.176	3.152	2.624	0.348
15 x 20 x 40	12.150	8.104	6.072	5.064	0.675
20 x 20 x 40	18.072	12.000	9.000	7.504	1.000

Comment:

Comparing the answers of the three methods in finding the materials for cement mortar, the results are practically the same. The estimator now has the choice which method to use, but before using Table 2-2 and 2-3, know first the kind of mixture and the size of CHB to be used because this is where most errors are being committed.

ILLUSTRATION 2-6

Going back to the problem of Illustration 2-2, Figure 2-4, find the quantity of hollow blocks, cement and sand, for mortar using the area method of estimating.

SOLUTION:

1. Find the area of the wall.

   Area = Perimeter x Height

   A = 60.00 m. x 2.60 m.

   A = 156 square meters

2. Find the number of CHB. Refer to Table 2-2, under column number per sq. m. multiply:

   156 x 12.5 = 1,950 pieces

3. Find the cement and sand. Refer again to Table 2-2, using class B mortar; Multiply:

Cement: 156 x .522 = 81.43 say 82 bags

Sand: 156 x .0435 = 6.78 say 7 cu. m.

4. Summary of the materials:

1,950 pieces CHB

82 bags cement

7 cubic meters sand.

Take note that the above materials found does not include the cement, sand and gravel for the footing. For this item, refer to Chapter 1 where it was thoroughly discussed.

2-3 CEMENT MORTAR FOR PLASTERING

Aside from the cement mortar for block laying, plastering is another item to consider. Most estimators however, make their estimate of mortar for block laying and plastering through simple guessing and calculation, assuming the quantity of cement and sand without the pain of computation. The reason is simple, they are just in a hurry and has no time to do it. And for this reasons, we offer the following methods accompanied by a simplified tables of equivalent values.

Estimating the cement mortar for plastering can be done by:

1. The Volume Method and
2. The Area Method

ILLUSTRATION 2-7

Continuing the problem of Illustration 2-1, find the cement and sand necessary to plaster two sides of the 3.00 x 4.00 meters wall.

SOLUTION (By Volume Method)

1. Find the two sides area of the wall.

   A = 3.00 x 4.00 x 2 sides
   A = 24 sq. m.

2. Assuming that the plaster is 16 mm (.016 m.) average thickness, determine the volume of the plaster.

   V = 24 sq. m. x .016
   V = .384 cu. m.

3. Solve for the cement and sand. Refer to Table 2-1. Using 40 kg. cement class "B" mixture; multiply:

   Cement : .384 x 12.0 = 4.6 say 5 bags .
   Sand : .384 x 1.0 = .384 say fine sand.

TABLE 2-4 QUANTITY OF CEMENT AND SAND FOR PLASTER PER SQUARE METER AREA

Mixture Class	Cement in Bags Thickness of Plaster				
	8 mm	12 mm	16 mm	20 mm	25 mm
A	.144	.216	.288	.360	.450
B	.096	.144	.192	.240	.300
C	.072	.108	.144	.180	.225
D	.060	.090	.120	.150	.188
Sand	.008	.012	.016	.020	.025

SOLUTION – 2 (By Area Method using Table 2-4)

1. Find the area of the wall (two sides)

   Area = 3.00 x 4.00 x 2 sides
   A = 24 sq. m.

2. Solve for the cement and sand. Refer to Table 2-4. Under 16 mm thick plaster class "B" mixture, multiply:

Cement : 24 x .192 = 4.6 say 5 bags
Sand : 24 x .016 = .384 cu. m.

Comparing the answers of the two methods, the results are practically the same. As to what method to use depends on your choice and convenience.

ILLUSTRATION 2-8

From the following Figure 2-9, list down the cement and sand necessary to plaster the two faces of the fence at an average thickness of 20 mm. class "C" mixture.

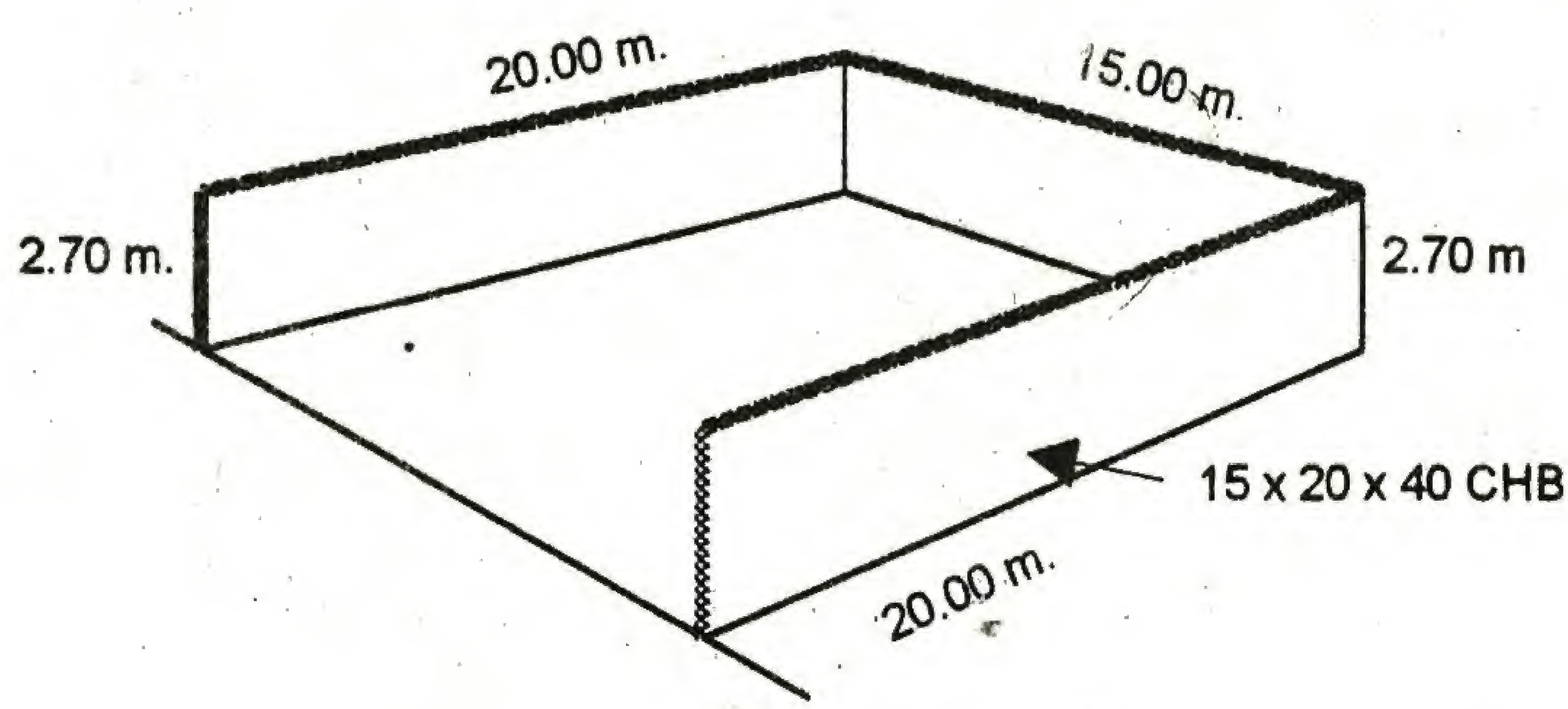


FIGURE 2-9 PLASTERING

SOLUTION (By the Area Method)

1. Find the surface area of the fence.

Area = Perimeter x Height x 2 faces
A = 55 m. x 2.70 m. x 2 faces
A = 297 sq. m.

2. Solve for the area of the front and the top surface of the fence.

A = .15 x (2.70 + 2.70 + 40.00 + 15.00)
A = 9.06 sq. m.

3. Total Area to be plastered add 1 and 2

Total Area = 297 + 9.06 = 306.06 sq. m.

4. Find the cement and sand. Refer to Table 2-4. Under 20 mm thick along class "C" mixture; multiply:

Cement : 306.06 x .180 = 55 bags
Sand : 306.06 x .020 = 6.1 cu. m.

ILLUSTRATION 2-9

The owner of a commercial lot wants to fence the frontage of his lot with 15 x 20 x 40 cm. concrete hollow blocks. The fence is 3.50 meters high and 40 meters long provided with a 25 x 25 cm. reinforced concrete posts spaced at 4.00 meters distance. Using class B mixture list down the materials required.

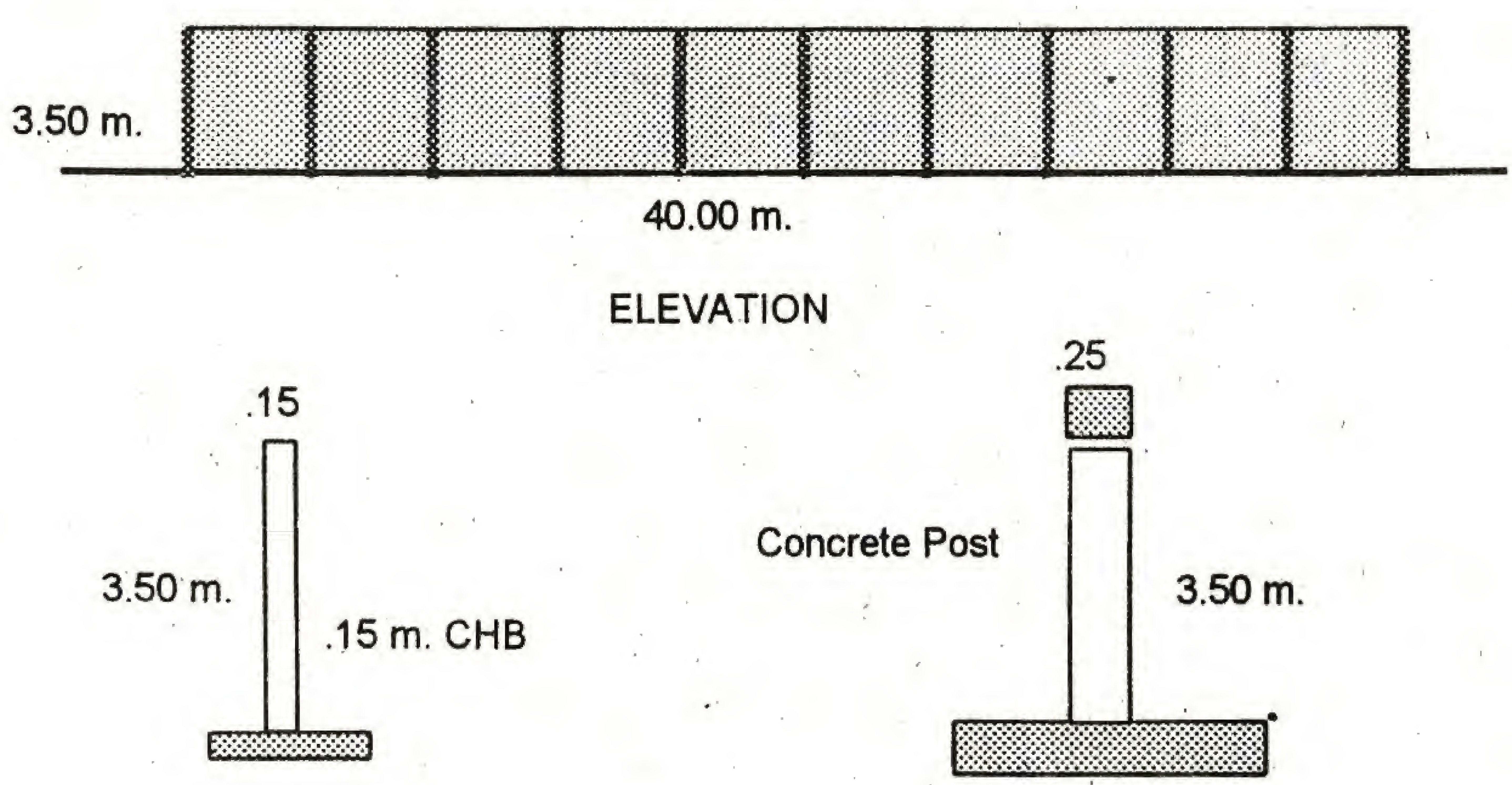


FIGURE 2-10

SOLUTION

1. Solve for the gross area of the fence.

Gross Area = (3.50 x 40.00) = 140 sq. m.

2. Subtract the area occupied by the posts.

Net Area = 140 sq. m. – (.25 x 3.50 ht. x 11 posts.)

A = (140 – 9.625) = 130.4 sq. m.

3. Find the number of CHB. Refer to Table 2-2, multiply:

130.4 sq. m. x 12.5 = 1,630 pieces.

4. Find the cement mortar. Refer to Table 2-2. Using class "B" mixture for a 15 x 20 x 40 CHB; multiply:

Cement : 130.4 x 1.018 = 132.75 bags
Sand : 130.4 x .0844 = 11.0 cu. m.

5. Solve for the cement plaster. Refer to Table 2-4. Using 16 mm thick plaster, class "B" mixture, multiply:

130.4 sq. m. x 2 sides = 261 sq. m.

Cement : 261 x .192 = 50 bags
Sand : 261 x .016 = 4.2 cu. m.

Summary of the Materials

1,630 pcs. 15 x 20 x 40 cm. CHB
183 bags cement
16 cu. m. sand

Comment:

1. Take note that in finding the wall area, the height should be measured from the top of the fence down to the foundation line not just to the floor line only.
2. In the preceding example, two sides of the wall were considered for plastering. The area occupied by the posts was subtracted from the gross wall area. For practical purposes it should not be subtracted because by computing back to determine its area and the plaster required is considerably a waste of time.

3. The area to be plastered is 140 x 2 sides or 280 square meters including the space occupied by the posts.

2-4 CONCRETE HOLLOW BLOCK FOOTING

Concrete hollow block wall, is supported by a continuous wall footing of various thickness and width, depending upon the size of the blocks and the load it has to carry or as indicated in the plan. Table 2-5 was prepared for easy reference in estimating the materials for concrete hollow blocks footing.

TABLE 2-5 QUANTITY OF CEMENT, SAND AND GRAVEL FOR CHB FOOTING PER METER LENGTH

Dimension Centimeters	Cement in Bags Class Mixture			Aggregates	
				Sand	Gravel
T x W	A	B	C	cu. m.	cu. m
10 x 30	.270	.225	.180	.015	.030
10 x 35	.315	.263	.210	.018	.035
10 x 40	.360	.300	.240	.020	.040
10 x 50	.450	.375	.300	.025	.050
15 x 40	.540	.450	.360	.030	.060
15 x 45	.612	.510	.048	.034	.068
15 x 50	.675	.563	.550	.038	.076
15 x 60	.810	.675	.540	.045	.090

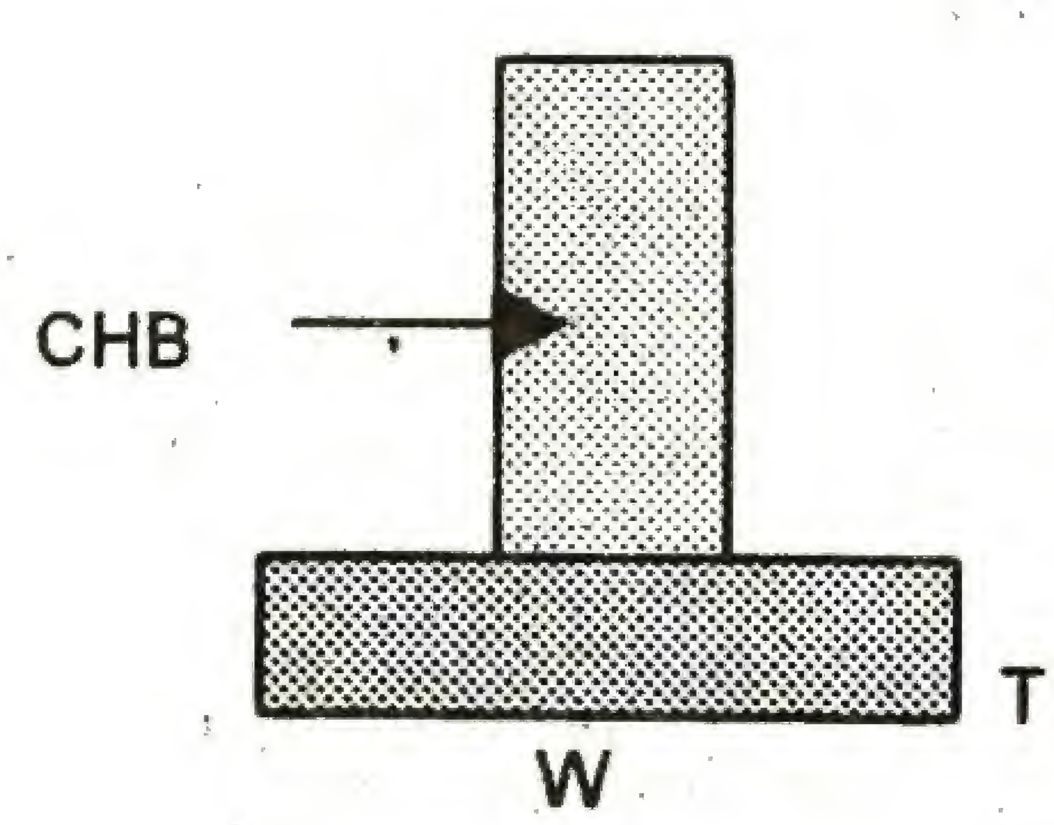


FIGURE 2-11 CROSS SECTION OF CHB FOOTING

ILLUSTRATION 2-10

Continuing the problem of Illustration 2-9, Figure 2-10, if the wall footing is 15 centimeters thick and 50 centimeters wide, determine the quantity of cement, sand and gravel necessary using class "A" concrete.

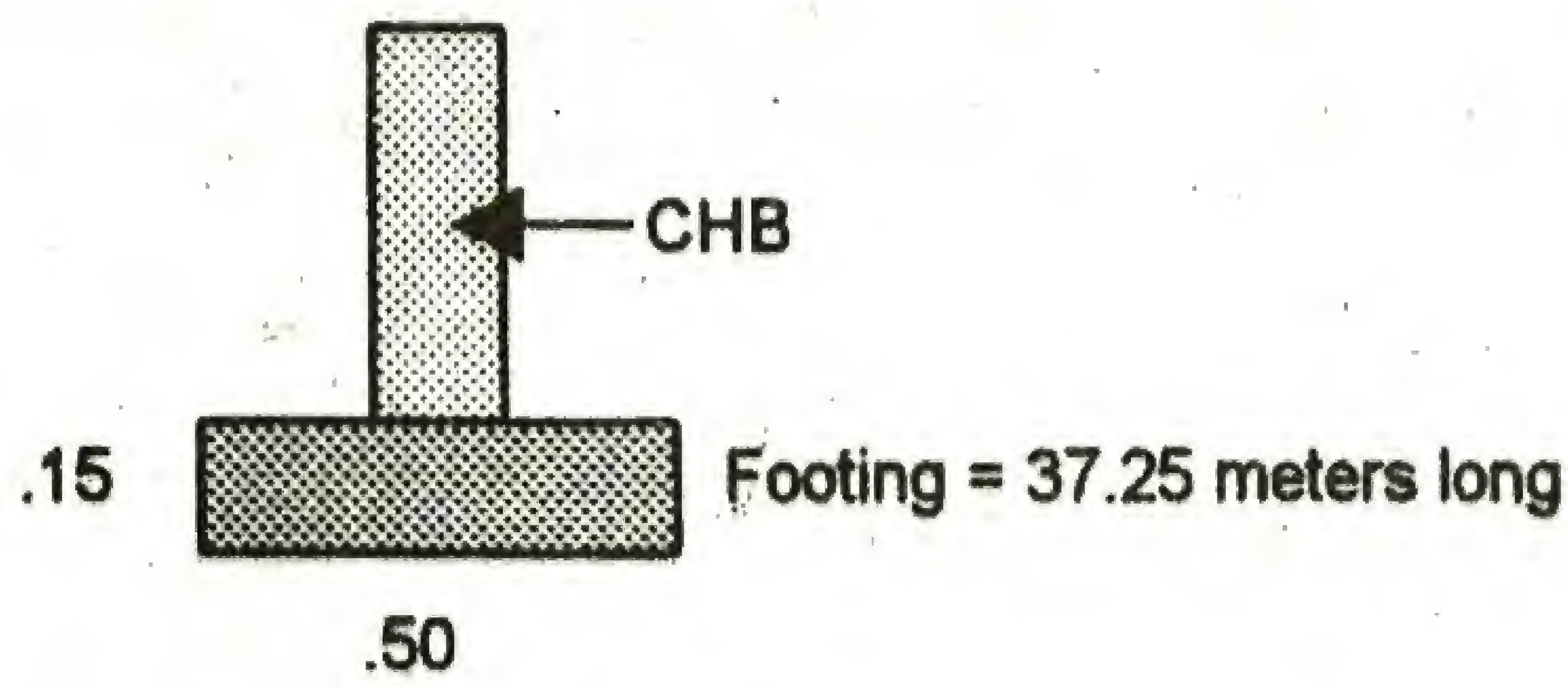


FIGURE 2-12 CHB FOOTING

SOLUTION –1 (By Volume Method)

1. Find the volume of the wall footing. Length minus the space occupied by the posts to get the net length.

   40.00 m. – (.25 x 11 posts)
   40.00 - 2.75 = 37.25 m. net length
   Volume = .15 x .50 x 37.25 m. = 2.79 cu. m.

2. Refer to Table 1-2. Using class "A" concrete; multiply:

   Cement : 2.79 x 9.0 = 25 bags
   Sand : 2.79 x .50 = 1.4 cu. m.
   Gravel : 2.79 x 1.0 = 2.8 cu. m.

SOLUTION – 2 (By the Linear Meter Method)

1. Solve for the Net Length of the CHB wall.

   Net length = 40.00 m. – (.25 x 11 posts) = 37.25 m.

2. Refer to Table 2-5. Along 15 x 50 cm. footing dimension class "A" mixture, multiply:

Cement: 37.25 x .675 = 25.14 bags
Sand: 37.25 x .038 = 1.42 cu. m.
Gravel: 37.25 x .076 = 2.83 cu. m.

ILLUSTRATION 2-11

From the following figure, prepare the bill of materials using class "B" mixture for concrete and mortar.

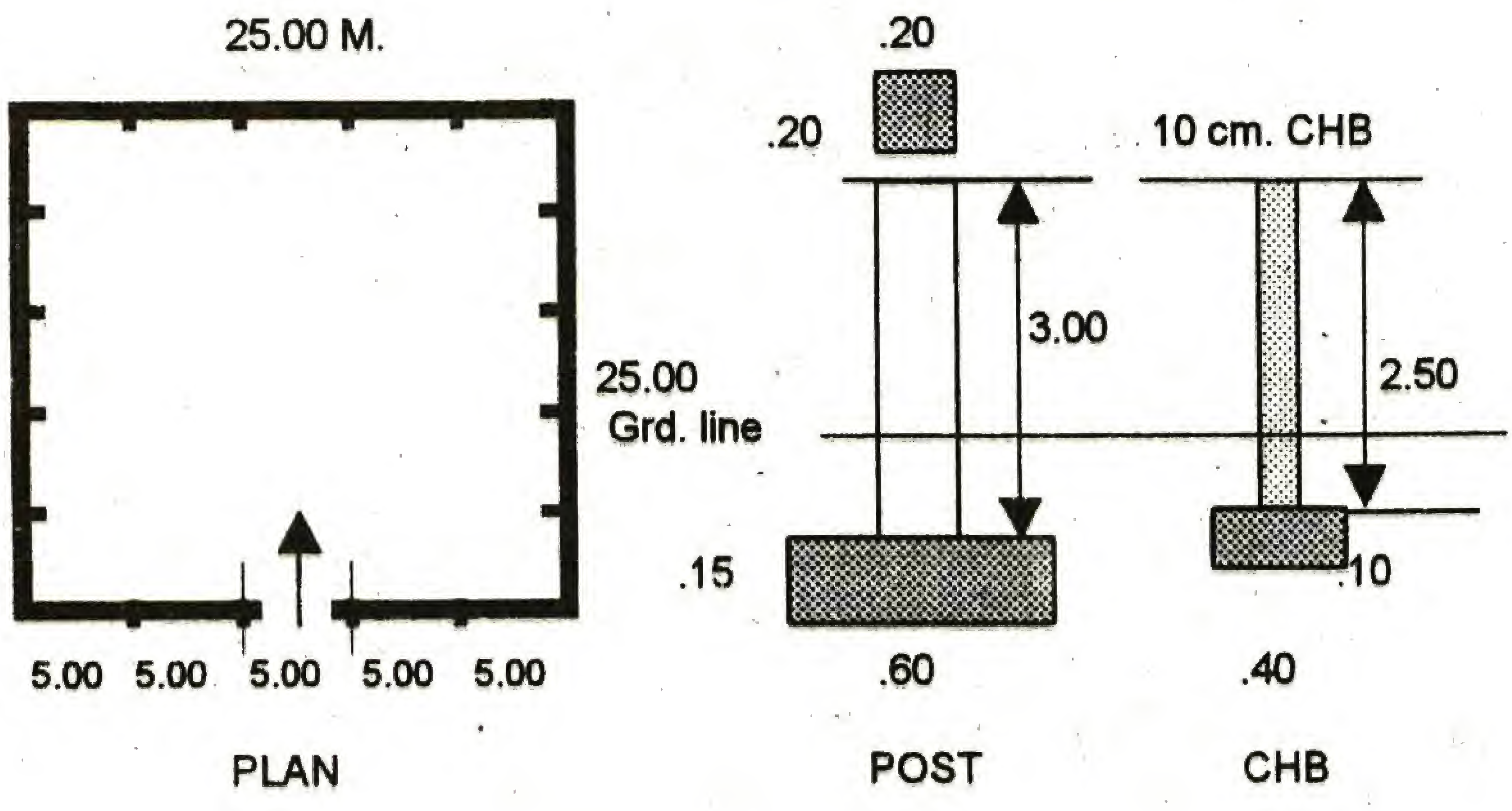


FIGURE 2-13

SOLUTION

A. Solving for CHB

1. Find the Perimeter of the hollow block fence.

$$P = 3\,(25.00) + 4(5.00)$$
$$P = 95.00 \text{ meters.}$$

2. Subtract the length occupied by the posts.

Length = .20 width x 20 posts (see figure)
L = 4.00 meters

3. Find the net length of CHB wall

L = 95.00 - 4.00 = 91.00 m.

4. Find the net area of the CHB wall fence.

Area = 91.00 x 2.5 m. ht. = 228 sq. m.

5. Find the number of 10 cm. CHB. Refer to Table 2-2, multiply:

228 x 12.5 = 2,850 pieces

B. Cement Mortar for Block Laying

1. Find the cement and sand for block laying. Refer to Table 2-2. Using class "B" mixture, multiply:

2. Cement : 228 x .522 = 119 bag
   Sand : 228 x .0435 = 9.92 say 10 cu. m.

C. Cement Mortar for Plastering

1. If two sides of the wall will be plastered, then:

   Area = 95.00 m. x 2.00 m. ht. x 2 sides
   A = 380 sq. m. (including the posts)

   Take note that the height of the wall is only 2.00 meters because we do not plaster the wall below the ground line.

2. For plastering, refer to Table 2-4. Using 16 mm thick plaster class "B" mixture; multiply:

   Cement : 380 x .192 = 73 bags
   Sand : 380 x .016 = 6.1 cu. m.

D. Solving for Concrete Post and Footing

1. Materials for CHB footing. The net length of the CHB

wall is 91.00 meters. Refer to Table 2-5. Using a 10 x 40 footing class " B" mixture; multiply :

Cement :	91.00 x .300 =	27.3 say 28 bags
Sand :	91.00 x .020 =	1.8 say 2.0 cu. m.
Gravel :	91.00 x .040 =	3.64 say 4.0 cu. m.

2. Find the volume of the concrete posts.

Volume = 20 posts x (.20 x .20) x 3.00 m. ht.
V = 2.4 cu. m.

3. Find the volume of the footing.

V = 20 footings x (.15 x .60 x .60)
V = 1.08 cu. m.

4. Total Volume of posts and footing. Add step 2 and 3

V = 2.4 + 1.08 = 3.48 cu. m.

5. Refer to Table 1-2. Using class "B" mixture; multiply:

Cement :	3.48 x 7.5 =	26.0 bags
Sand :	3.48 x .50 =	1.74 cu. m.
Gravel :	3.48 x 1.0 =	3.48 cu. m.

6. **Summary:**

2,850 pieces 10 x 20 x 40 cm. CHB
246 bags cement
20 cubic meter sand
7.5 cubic meter gravel

Problem Exercise

1. From the following figures, find the following materials required for its construction.
   a) 15 x 20 x 40 cm. concrete hollow blocks.
   b) Cement, and sand for mortar and plastering.

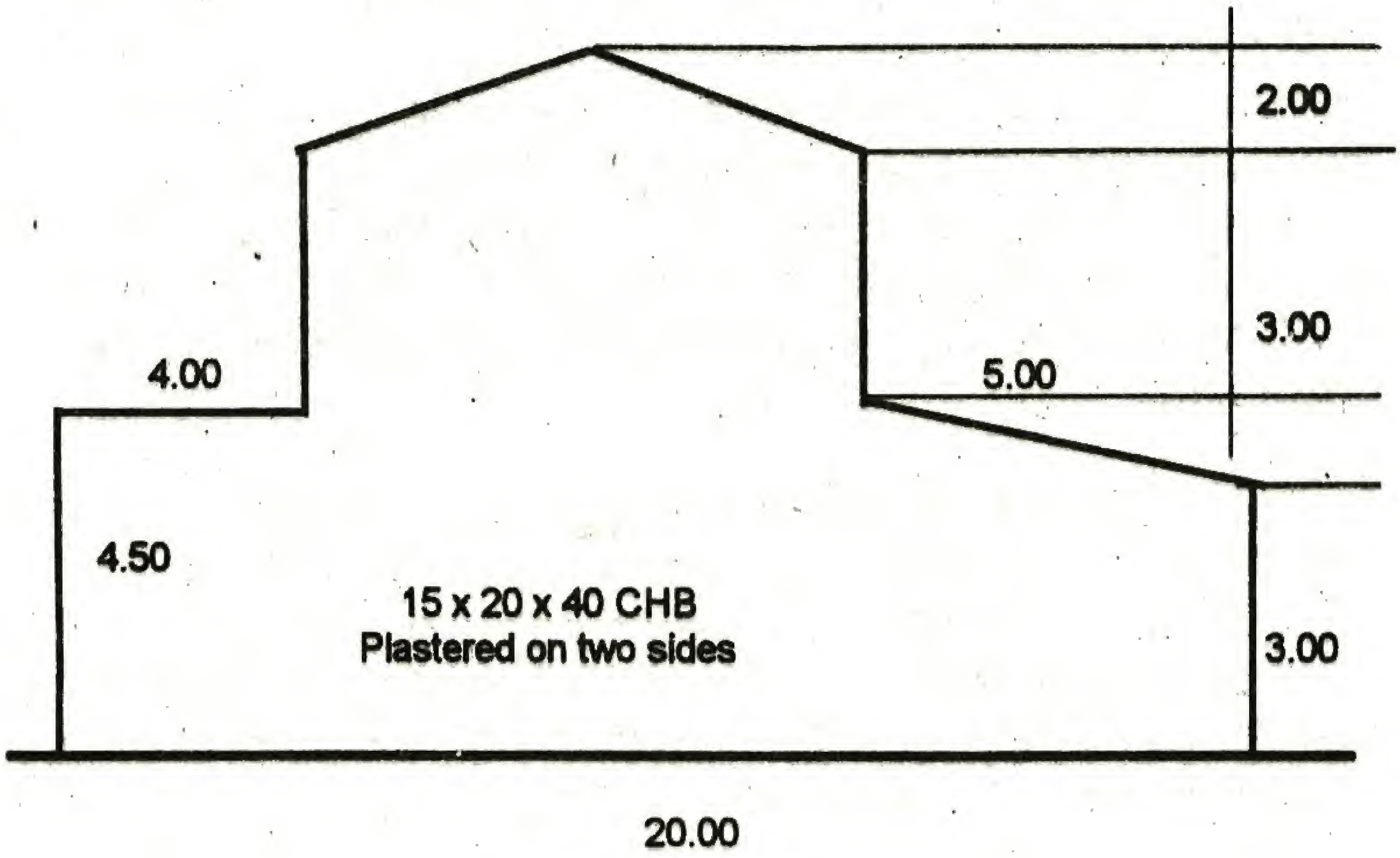
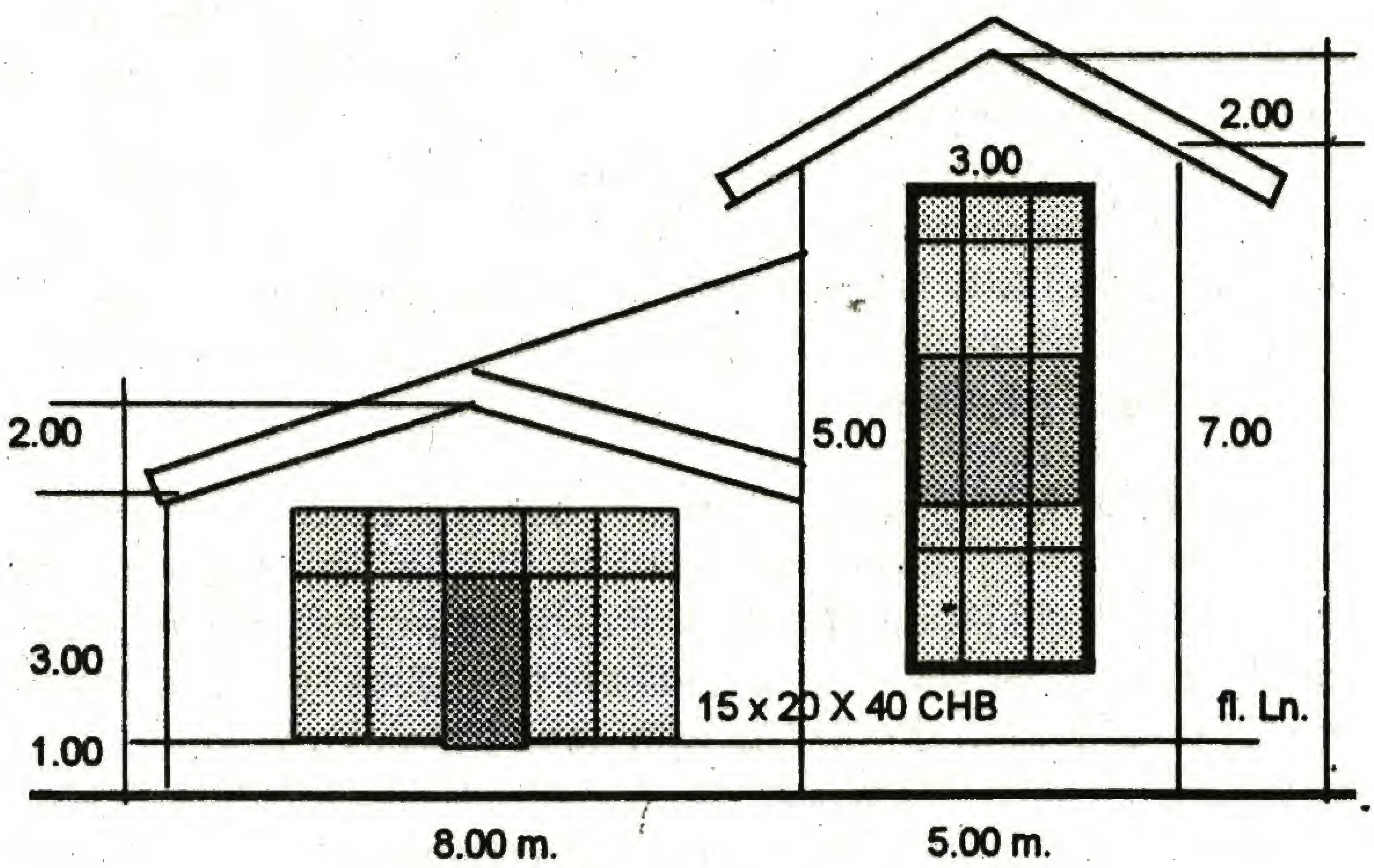


FIGURE 2-14 FIRE WALL



ELEVATION

FIGURE 2-15

2-5 OTHER TYPES OF CONCRETE BLOCKS

The standard common types of concrete hollow blocks are those with three hollow cores as explained in Section 2-1. There are however various type of blocks especially designed for architectural and structural purposes such as; the stretcher block, the L-corner block, the single end block, the half block and the beam block.

The purpose of making these types of blocks is to create a wider core to accommodate concrete and steel reinforcement. The estimating method is similar with the standard type of blocks using the constant value of 12.5 pieces per square meter and 25 pieces for the half block although this type is usually determined by direct counting.

In estimating the quantity of concrete hollow blocks, what is considered is the side portion of the block. The thickness is only used in computing the cement mortar for block laying.

The introduction of these special types of concrete hollow blocks facilitated the use of posts and beams for housing projects avoiding the much used of form lumber. The wall is designed as a continuous interlocking support of the roof framing. Corner blocks combined with stretcher blocks are used on corners provided with reinforcement instead of reinforced concrete post. With this method, the costs of forms and labor were felt as a substantial savings.

In block laying work, concrete being a mixture of cement, sand and gravel should be used to fill the hollow core of the blocks for economical reasons. If cement mortar will be used to fill the core, cost will be substantially high because of the higher cement content in proportion with sand without gravel.

Remember that cost is the primary consideration in any type of construction, and to use pure mortar to fill the hollow core of the blocks is costlier than to use a reinforced concrete walls even if forms are used. One can prove this by applying the principles as explained in chapter-1

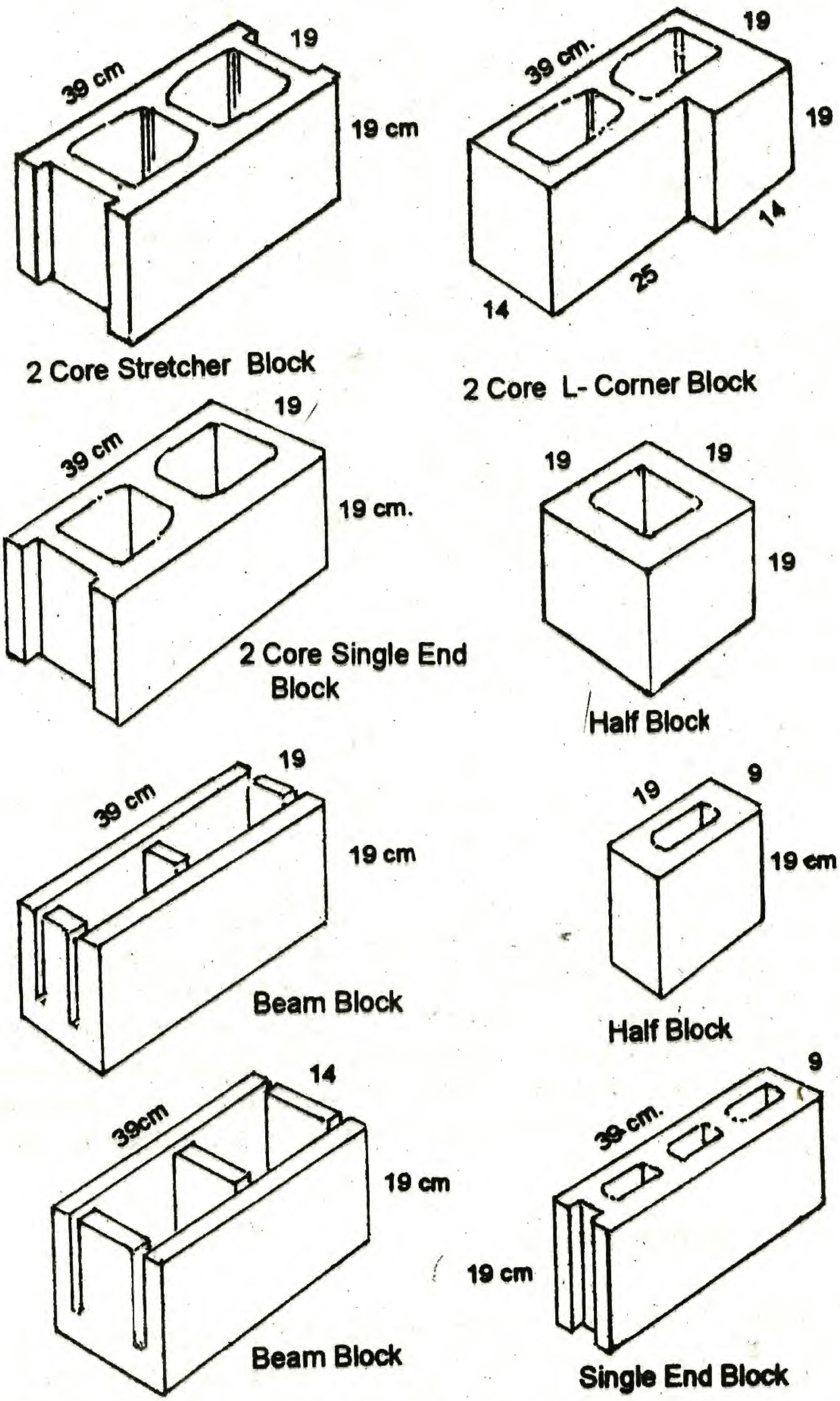


FIGURE 2-16 SPECIAL TYPES OF CHB

TABLE 2-6 QUANTITY OF CEMENT, SAND AND GRAVEL PER BLOCK

Size in Centimeters	40 kg. Cement in bag Class Mixture B	C	Sand	Gravel
Stretcher Block				
2- core 20 cm.	.0920	.0720	.0067	.0085
2- core 15 cm.	.0623	.0488	.0030	.0045
L – Corner Block				
2- core 20 cm.	.0867	.0687	.0060	.0095
2- core 15 cm.	.0590	.0467	.0041	.0070
Single End Block				
2- core 20 cm.	.0885	.0698	.0063	.0090
2- core 15 cm.	.0612	.0482	.0044	.0075
2- core 10 cm.	.0420	.0315	.0035	.0055
Half Block				
20 x 20 cm.	.0400	.0320	.0030	.0050
15 x 15 cm.	.0270	.0215	.0020	.0035
Beam Block	A	B		
2- core 20 cm.	.0878	.0732	.0050	.0098
2- core 15 cm.	.0585	.0488	.0040	.0070

The mortar for block laying is a mixture of cement and sand laid in between the layer of the blocks at approximately ½ of an inch or 12 mm as bonding materials. The hollow core is filled with concrete, a mixture of mortar and gravel. And to fill the core with pure mortar alone is a very costly construction undertaking to the advantage of cement manufacturer at the expense of the contractor. How to use the table, the following example is presented.

ILLUSTRATION 2-12

A masonry wall 15 cm. thick requires 1,500 pieces of 2-core stretcher blocks, 100 pieces single end block, 120 half block, 200 corner blocks and 80 pieces beam block. Find the cement sand and gravel using class "B" mortar mixture.

SOLUTION

1. Itemized the blocks according to its category and indicate the number of pieces.

2-core 15 cm. Stretcher block	1,500	pieces
Single end block	100	
Half block	120	
L-Corner Block	200	
Beam Block	80	

2. Refer to Table 2-6. Under column class "B" mixture, multiply the number of blocks to each corresponding value in the table to get the cement, sand and gravel required.

a.) 1,500 - Stretcher Blocks

Cement :	1,500 x .0623	= 93.45 bags
Sand :	1,500 x .0030	= 4.50 cu. m.
Gravel :	1,500 x .0045	= 6.75 cu. m.

b.) 100 - Single End Block

Cement :	100 x .0612	= 6.12 bags
Sand :	100 x .0044	= 0.45 cu. m.
Gravel :	100 x .0075	= 0.75 cu. m.

c.) 120 - Half Block

Cement :	120 x .0270	= 3.24 bags
Sand :	120 x .0020	= 0.24 cu. m.
Gravel :	120 x .0035	= 0.42 cu. m.

d.) 200 – L Corner Block

Cement :	200 x .0590	= 11.80 bags
Sand :	200 x .0041	= 0.82 cu. m.
Gravel :	200 x .0070	= 1.40 cu. m.

e.) 80 – Beam Block

Cement :	80 x .0488	= 3.90 bags
Sand :	80 x .0040	= 0.32 cu m.
Gravel :	80 x .0070	= 0.56 cu m.

3. Summary of the Materials

1,500	stretcher blocks	100	single end block
120	half block	200	L-corner block
80	beam block	119	bags cement
6.33	cu. m. sand	8.88	cu. m. gravel

2-6 DECORATIVE BLOCKS

Decorative hollow blocks are manufactured from either cement mortar or clay. These types of construction materials had been widely used for ventilation and decorative purposes.

TABLE 2-7 QUANTITY OF CECORATIVE BLOCKS CEMENT AND SAND PER 100 BLOCKS.

Size in	Cement in Bag at 40 kg.			Sand per
	Number	Class Mixture		
cm.	per sq. m.	A	B	100 blocks
5 x 10	200	.180	.120	.010
5 x 15	133	.270	.180	.015
5 x 20	100	.360	.240	.020
5 x 25	80	.450	.300	.025
10 x 20	50	.720	.480	.040
10 x 25	40	.900	.600	.050
10 x 30	33	1.080	.720	.060

TABLE 2-8 QUANTITY OF CEMENT AND SAND FOR VARIOUS TYPES OF BRICKS PER 100 BLOCKS

Size in Centimeters	Number	Cement in Bag 40kg Mixture Class		Sand per. 100
T H L	per sq. m.	A	B	blocks
6 x 12 x 19	38.5	.346	.230	.019
10 x 14 x 19	33.3	.612	.408	.034
10 x 14 x 23	27.8	.684	.456	.038
10 x 24 x 24	16.0	.882	.588	.049
10 x 14 x 39	16.7	.972	.648	.054
10 x 19 x 39	12.5	1.062	.708	.059

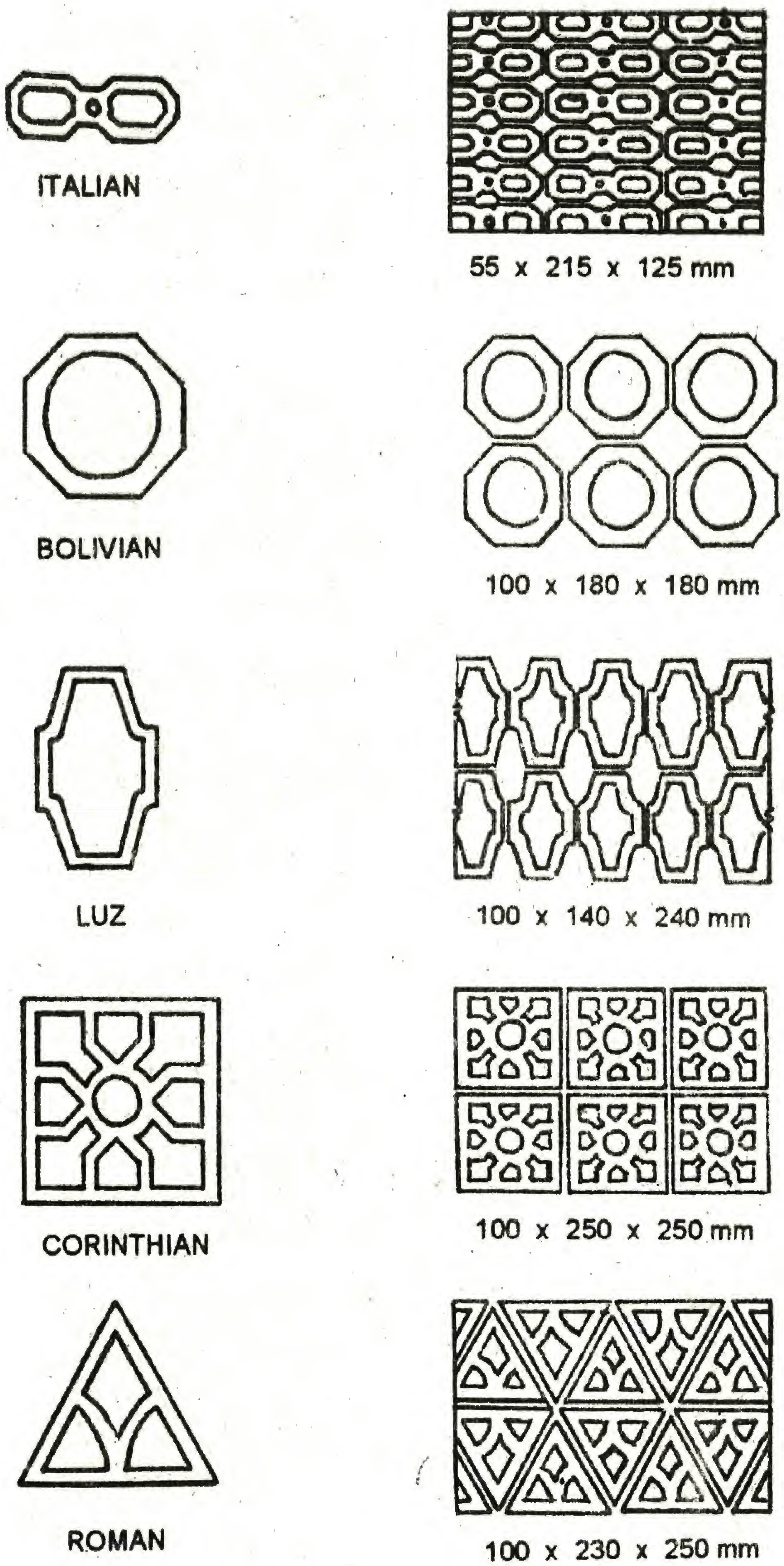
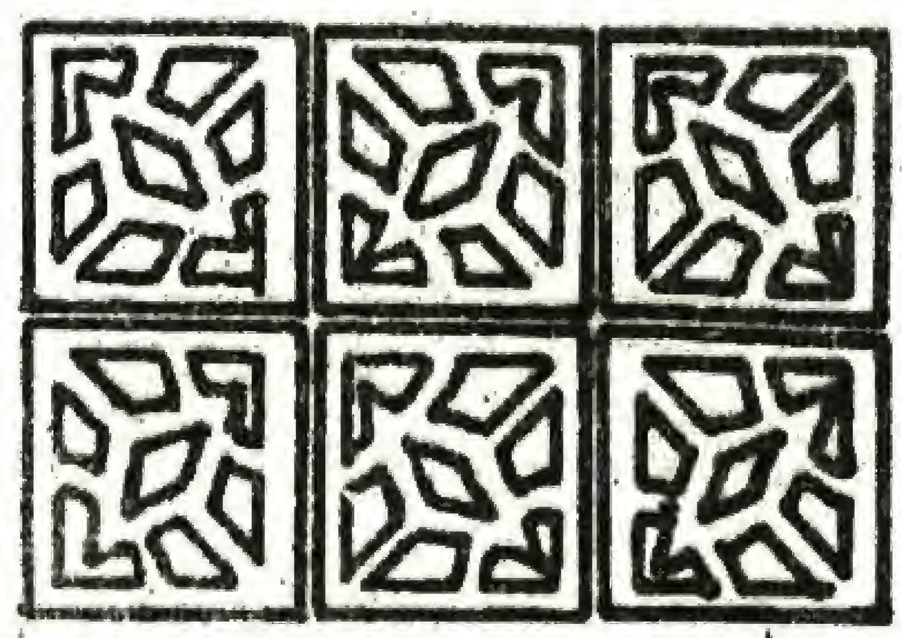


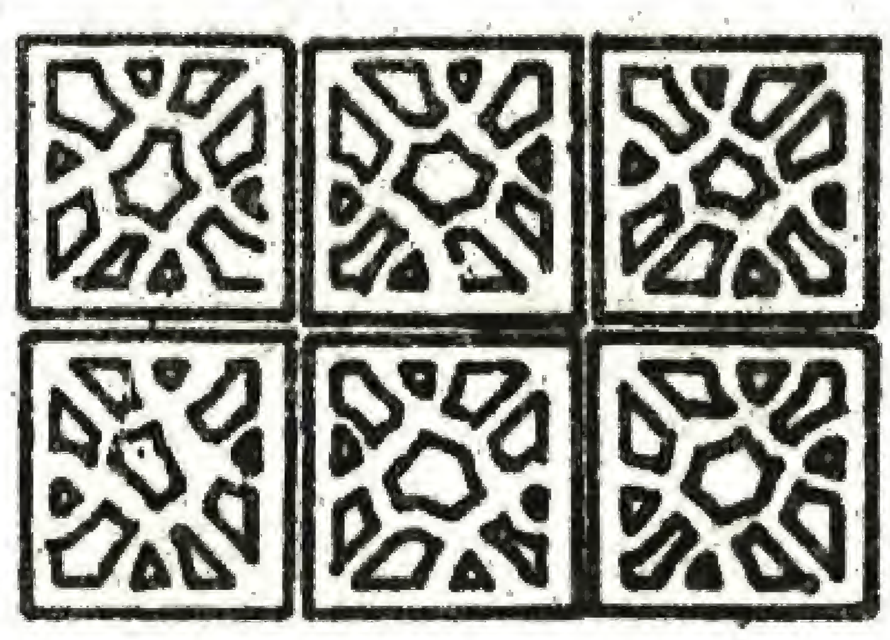
FIGURE 2-17 DECORATIVE BLOCKS

JOSEPHINE



100 x 250 x 250 mm

ASG



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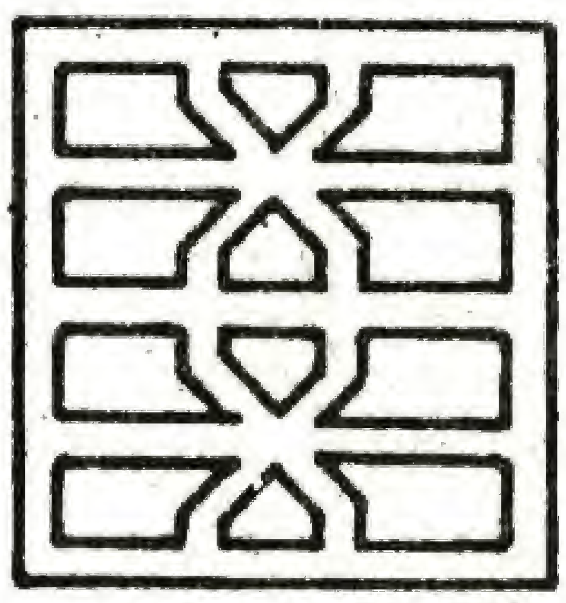
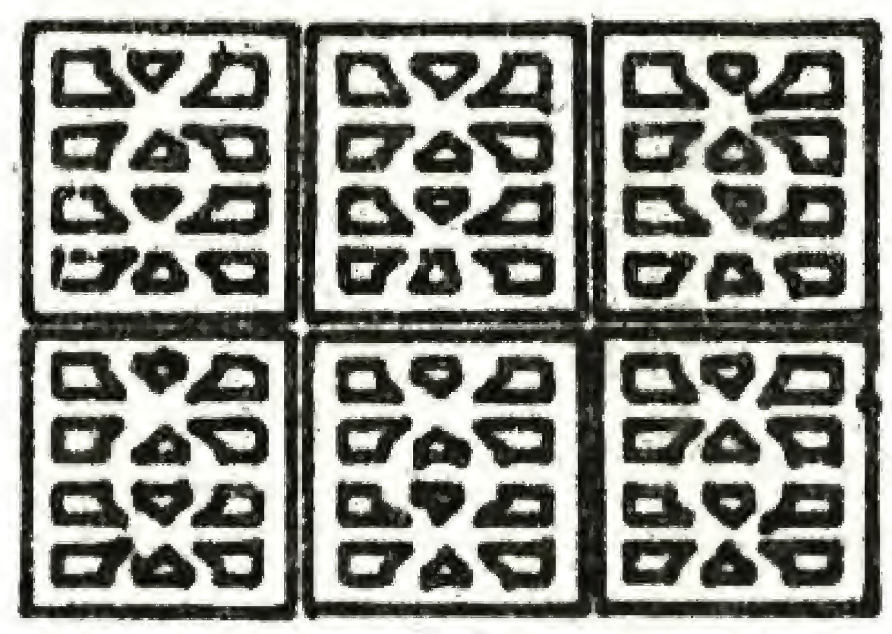


AUM



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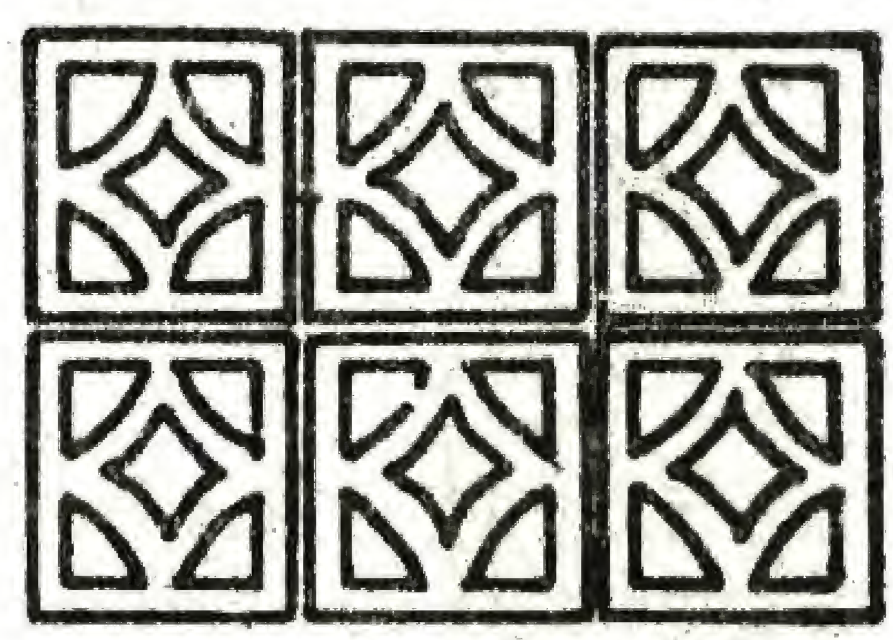
EGYPTIAN



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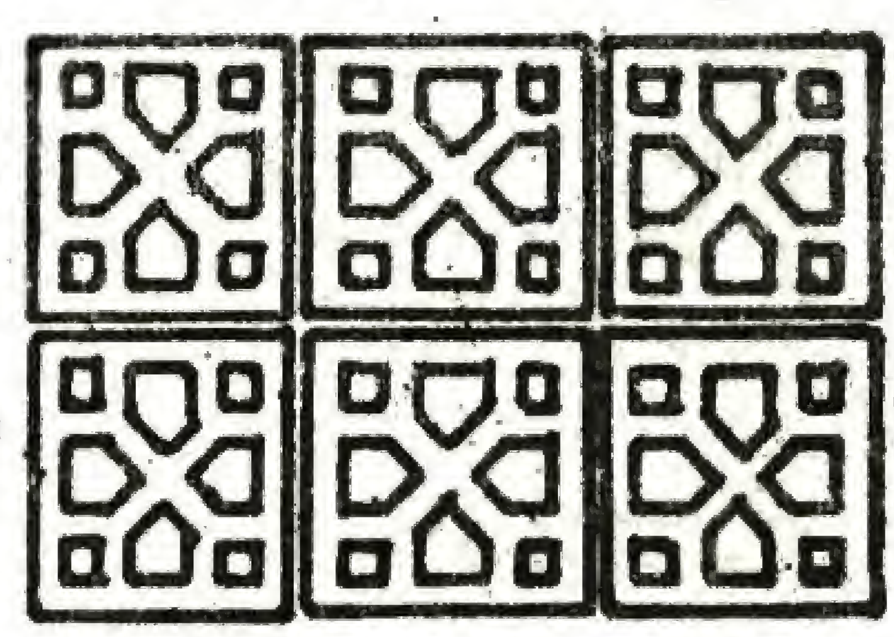
PERSIAN



100 x 250 x 250 mm

FIGURE 2-18 DECORATIVE BLOCKS

2-7 ADOBE STONE

Adobe Stone is commonly used for fencing materials as substitute to concrete hollow blocks for economic reasons. Lately however, the used of adobe stone was no longer limited to the ordinary zocalo and fencing work but also extensively used as finishing and decorative materials for exterior and interior of buildings and other related structures.

The use of adobe stone for fences, buttresses, cross- footings, and stairs minimizes the use of mortar filler unlike in working with concrete hollow blocks. Plastering is sometimes not applied specially when the design calls for exposure of the natural texture of the stone.

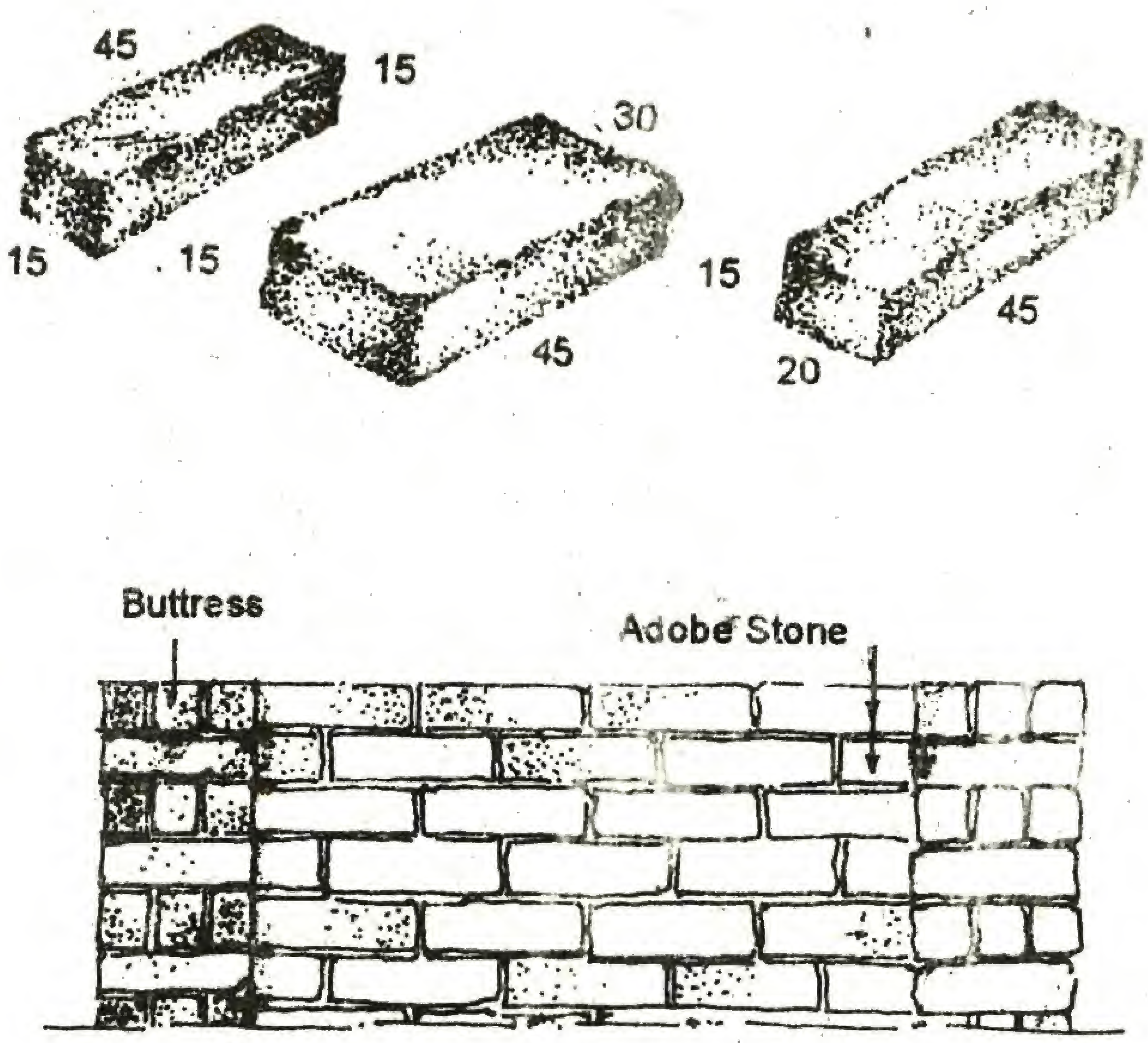


FIGURE 2-19 ADOBE STONE

Three tables were prepared to simplify the process of obtaining the quantity of adobe stone and cement mortar for stone laying and plastering.

TABLE 2-9 QUANTITY OF CEMENT AND SAND FOR ADOBE MORTAR PER SQUARE METER.

Commercial Size in cm.	No. per sq. m.	40 kg. Cement in Bags Class of Mixture			Sand cu. m.
		B	C	D	
15 x 15 x 45	14.8	.173	.130	.108	.015
15 x 20 x 45	11.0	.132	.099	.083	.011
15 x 30 x 30	11.0	.088	.066	.055	.007
15 x 30 x 40	8.3	.089	.067	.056	.008
15 x 30 x 45	7.4	.091	.068	.057	.008

* Mortar at an average thickness of 16 mm.

TABLE 2-10 QUANTITY OF ADOBE STONE CEMENT AND SAND FOR BUTRESSES AND FOOTINGS

Buttress and Footing			Cement per Meter Ht. Class of Mixture			Sand
Buttress Cross Section	No. of course	Number of stone per. M. ht.	A	B	C	cu. m.
30 x 45	2	12	.233	.156	.117	.013
45 x 45	3	18	.350	.233	.175	.019
45 x 60	4	24	.468	.312	.234	.026
45 x 75	5	30	.583	.389	.292	.032
45 x 95	6	36	.702	.468	.351	.039

* Mortar at an average thickness of 16 mm.

ILLUSTRATION 2-13

From Figure 2-20, find the quantity of adobe stone, cement and sand using class "B" mortar.

SOLUTION

A. Solving for Adobe Stone Wall

1. Determine the length of the fence minus the space occupied by the buttresses.

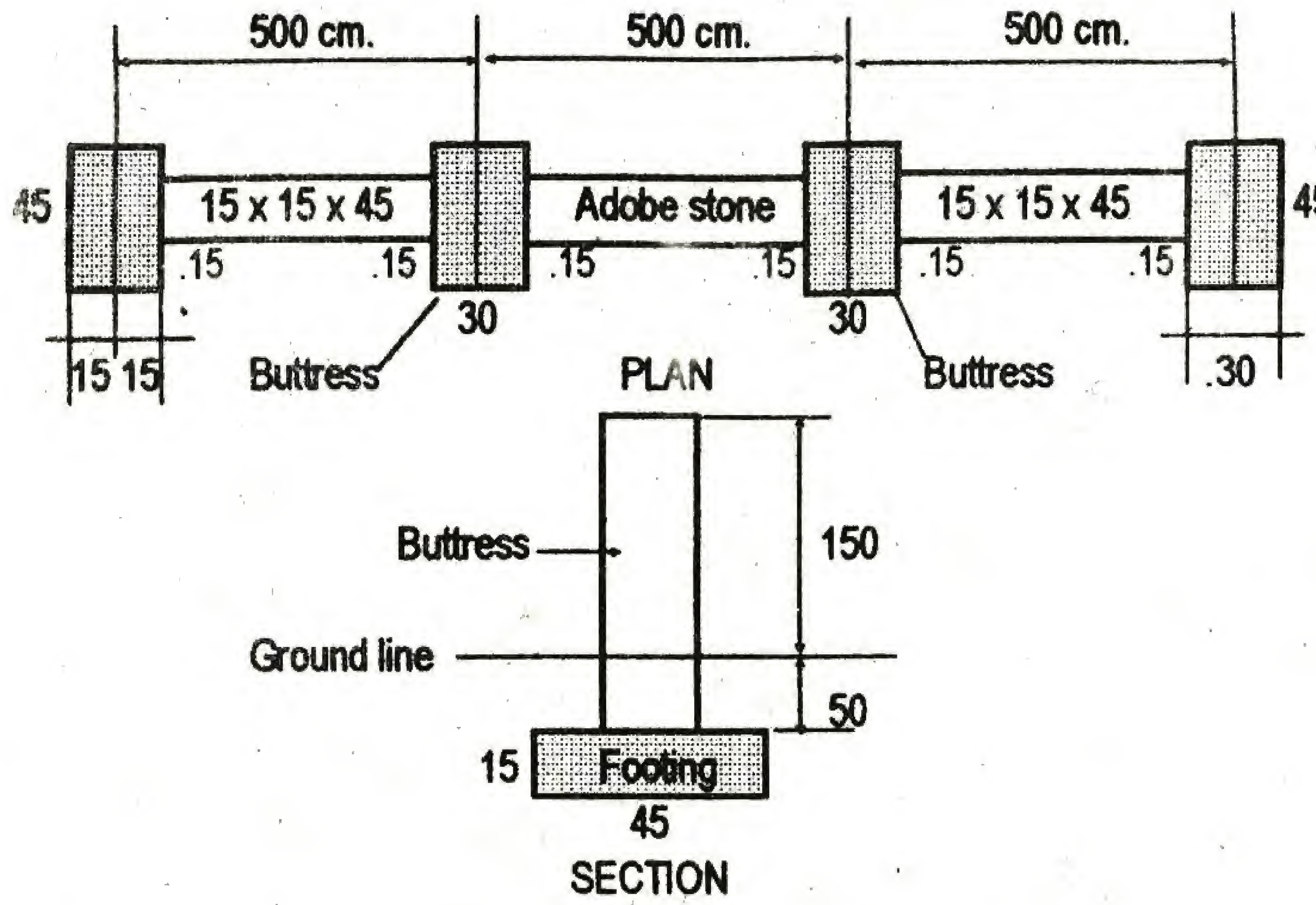


FIGURE 2-20 ADOBE FENCE

Length = 15.00 - (.30 x 3 posts)
(2 post plus the two 1/2 side posts = 3)

L = 14.10 meters

2. Solve for the net area of the wall.

Area = 14.10 x 2.00 m.
A = 28.20 sq. m.

3. Refer to Table 2-9. Using a 15 x 15 x 45 cm. adobe stone, multiply:

28.20 x 14.8 = 418 pieces

B. Solving for Buttresses

1. Find the total length of the post

2.00 m. x 4 posts = 8.00 meters

2. Refer to Table 2-10. Using a 30 x 45 buttress, multiply:

8.00 x 12 stone per meter height = 96 pieces.

3. For a 45 x 60 buttress footing refer to Table 2-10, the number of course is 4. Multiply:

   4 x 4 footings = 16 pieces

4. Add the results of 2 and 3.

   96 + 16 = 112 pieces

C. Solving for Wall Footing

1. Length of the fence minus the space occupied by the buttress footing.

   15.00 m. – (.45 x 3) = 13.65 m.

   3 is the 2 center posts plus the two 1/2 at the sides.

2. Multiply by 6 stones per meter length. The adobe stones are laid crosswise the wall, see figure 2-19.

   13.65 m. x 6 = 82 pieces.

D. Solving for the Cement Mortar

1. The area of the fence is 28.20. Refer to Table 2-9. Using class "B" mortar, multiply:

   Cement : 28.20 x .281 = 8.0 bags
   Sand : 28.20 x .024 = .68 cu. m.

2. For buttresses and footing = 112 pieces stone. Refer to Table 2-10. Along 30 x 45 buttress class "B" mixture multiply:

   Cement : 112 x .027 = 3.0 bags
   Sand : 112 x .0023 = .26 cu. m.

3. **Mortar for wall footing** = 82 pieces. Refer to Table 2-10, using class "B" mixture; multiply:

Cement : 82 x .027 = 2.2 bags
Sand : 82 x .0023 = .19 cu. m.

TABLE 2-11 QUANTITY OF CEMENT AND SAND FOR PLASTERING ADOBE STONE PER SQUARE METER *

Side	Cement in Bag 40 kg. Class of Mixture			Sand cu. m.
	B	C	D	
One Face	.240	.180	.150	.020
Two Faces	.480	.360	.300	.040

* Cement Plaster at an average thickness of 20 mm

D. Solving for Cement Plaster

1. Find the total surface area of the wall and the buttresses to be plastered. (one face)

Length = 15.00 + 2 (.15) + (.15 x 6) = 16.2 m.
Area = 16.2 x 1.50 ht. = 24.3 sq. m.

2. The height is only 1.50 because we do not plaster the wall below the ground line. Refer to Table 2-11. Using class "B" mixture, multiply:

Cement : 24.3 x .240 = 5.83 say 6 bags
Sand : 24.3 x .020 = .49 cu. m.

3. This is for one side plaster only. If two sides will be plastered, double the quantity.

Summary of the Materials

612 pieces. 15 x 15 x 45 cm. adobe stone
20 bags Portland cement
2.0 cubic meters sand

Problem Exercise

From the following figure, find the number of 15 x 20 x 45 cm. adobe stone, the cement and sand required to construct the fence using (a) Class A mixture; (b) Class C mixture. The plan specify plastering both sides of the wall using class B mixture.

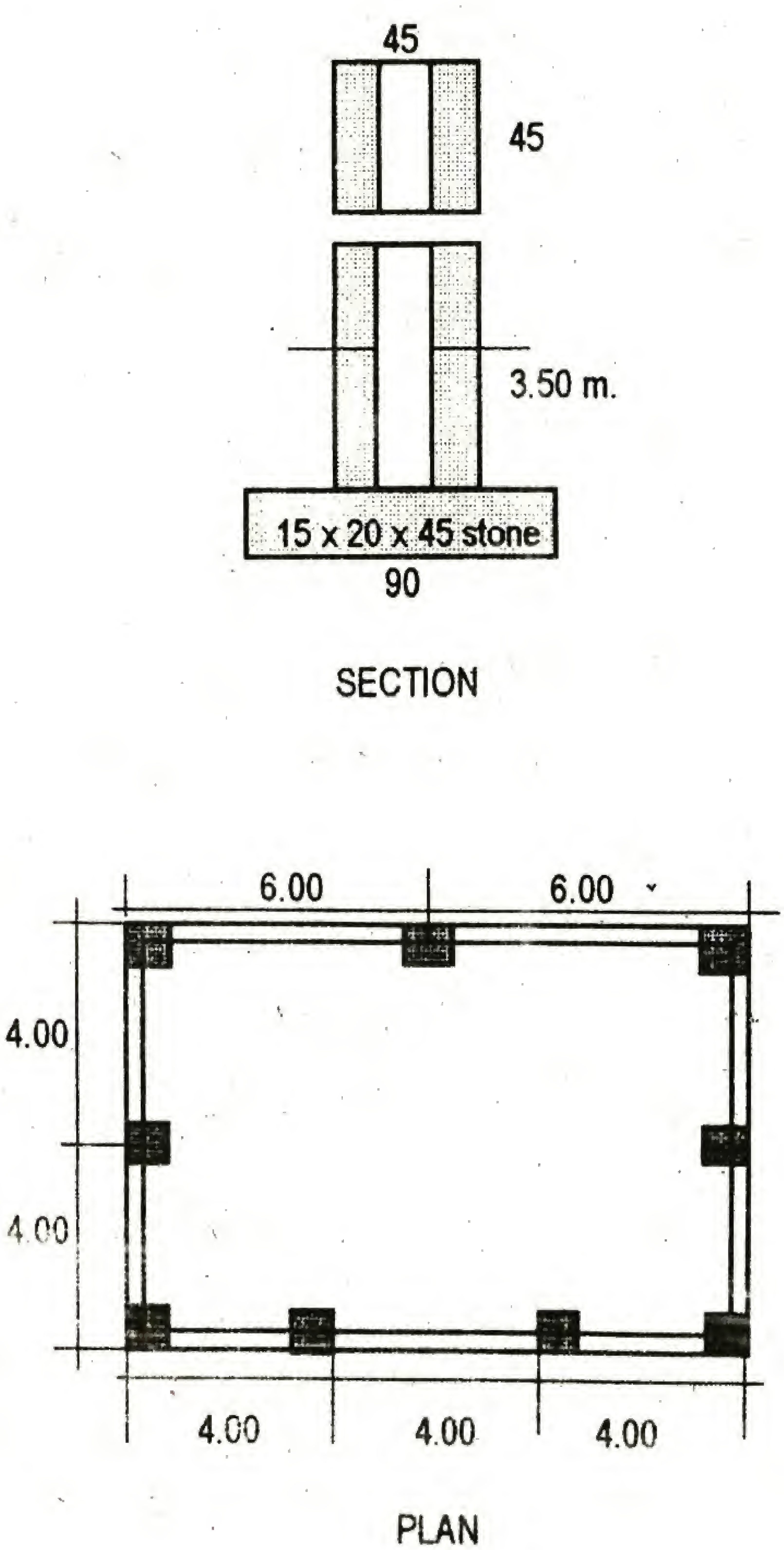


FIGURE 2-21

2-8 RETAINING WALL

The practical use of gravity retaining wall is controlled by height limitations. Indeed, the required wall cross section increases with heights due to the effect of the triangular soil pressure distributed behind the retaining wall.

If the ground water level rises into the backfill behind a retaining wall due to either changing ground water condition or percolating water surface, the lateral pressure against the wall is also changed. The combined effect of soil and water pressure causes overturning moments and sliding forces. This is greater than the condition where there is no water.

To avoid the rise of water that is building up behind the retaining wall, a weep hole or collector drainage system or both are provided as part of the design construction. Weep holes should be at least 3 inches in diameter provided with a granular soil filter fabric at the wall to prevent backfill erosion. The horizontal spacing ranges from 120 to 300 centimeters apart.

For taller walls, two or more rows of weep holes may be provided with a typical vertical spacing of 150 centimeters.

A Satisfactory Retaining Wall Design must Satisfy the Following Criteria

1. The base and stem of the retaining wall must be capable of resisting the internal shear and bending moments developing as a result of soil and other loadings.
2. The wall must be safe against overturning.
3. The wall structure must be safe against sliding
4. The bearing capacity of the foundation material supporting the wall must not be exceeded.

2-9 RIP-RAP AND GROUTED RIP-RAP

Rip-Rap is either with or without grout, with or without filter backing. Stones intended for rip-raping shall consist of rocks

which are nearly rectangular in section as possible. The stone shall be tough, durable and dense. It shall be resistance to the action of air and water and suitable in all aspects for the purpose intended. Adobe stone shall not be used unless specified.

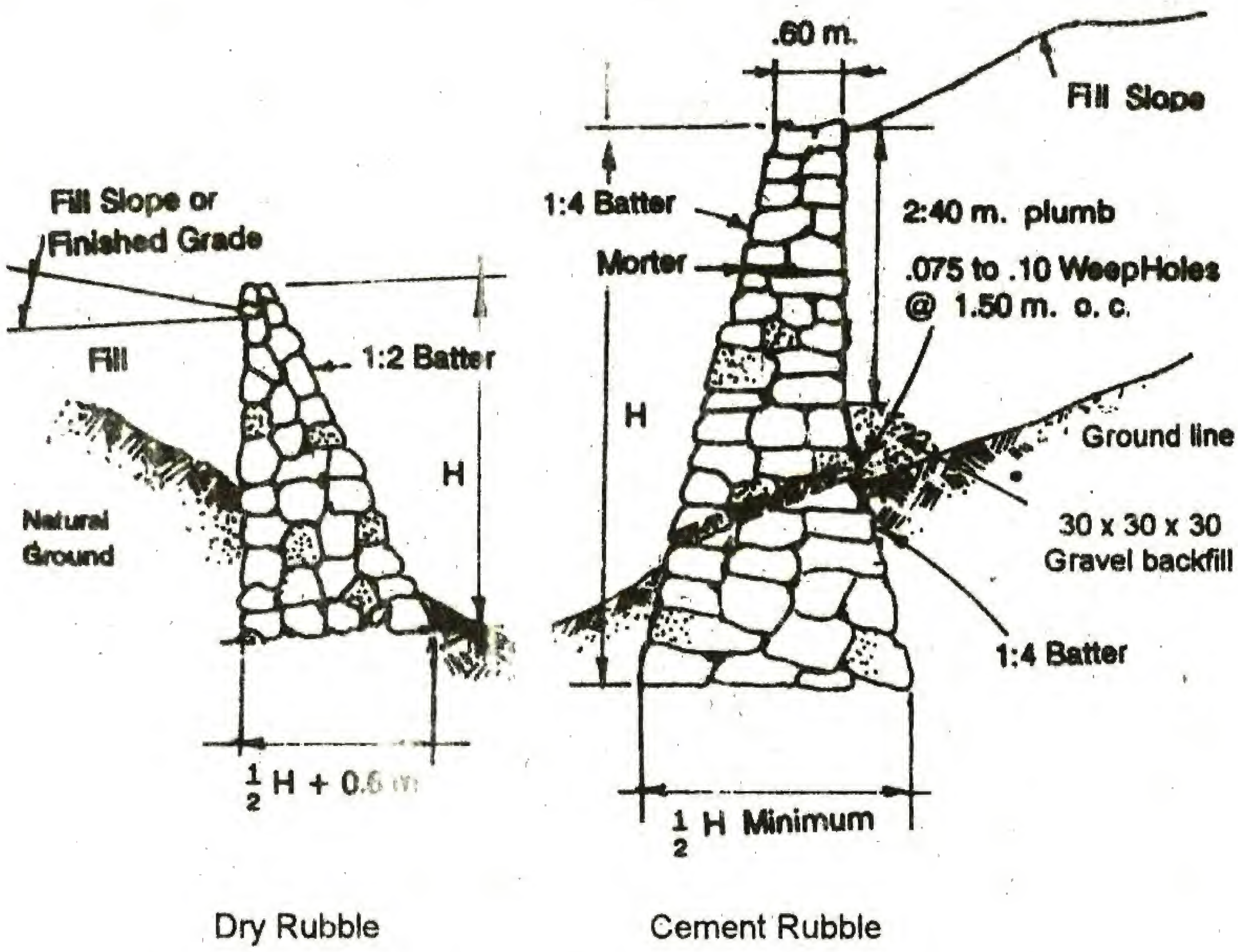


FIGURE 2-22 CROSS SECTIION OF RUBBLE RETAINING WALL

Class of Stone for Rip Raping

Class A - Stone ranging from 15 to 25 kilograms with at least 50% of the stones weighing more than 20 kilograms

Class B - Stone ranging from 30 to 70 kg. With at least 50% of the stones weighing more than 50 kilograms.

Class C - Stones ranging from 60 to 100 kg. With at least 50% of the stones weighing more than 80 kilograms.

Class D - Stones weighing from 100 kg. to 200 kg. with at least 50% of the stones weighing more than 150 kgs.

Excavation and Placing

The bed for rip-rap is excavated down to the required depth and properly compacted, trimmed and shaped. The rip-rap foundation is laid below the depth of the scour filling the toe trench with stone of the same class as specified.

Each stone is laid with its longest axis perpendicular to the slope in close contact with adjacent stone. The rip-rap is thoroughly rammed into place and the finished stones are laid to an even tight surface. Intersections between stones are filled with small broken fragments firmly rammed into place.

The stones are placed by hand or individually laid by machine. Spaces between stones are then filled with cement mortar sufficient enough to completely fill all the voids except the face surface of the stones left exposed.

Cement grout is placed starting from the bottom to the top of the surface and then swept with a stiff broom. After grouting, the surface is cured like structural concrete for a period of at least 3 days after the installation.

TABLE 2-12 QUANTITY OF CEMENT AND SAND ON A STONE RIP-RAP PER CUBIC METER

Stone Class	Cement in Bags — Grout Mixture A	B	C	Sand cu. m.
Class - A	2.574	1.716	1.287	.143
Class - B	2.448	1.620	1.214	.135
Class - C	2.232	1.488	1.116	.124
Class - D	1.944	1.296	0.972	.108

ILLUSTRATION 2-14

A stone rip-rap retaining wall 50 meters long as shown in Figure 2-23 specify the use of Class B stone with class C grout

mixture. List down the materials required including the weep hole drain pipe and the gravel backfill as granular soil filter.

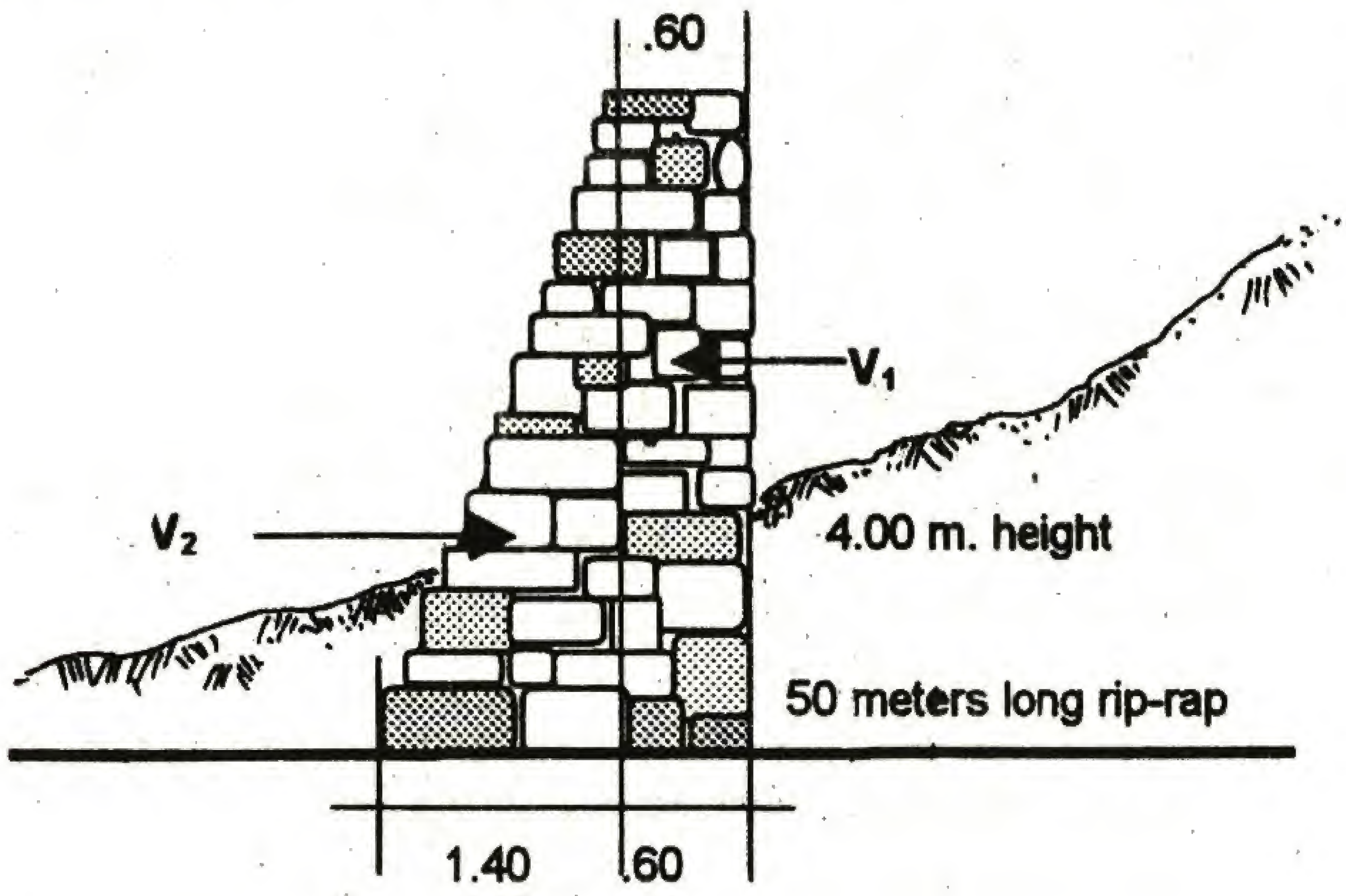


FIGURE 2-23

SOLUTION

1. Solve for the volume of the proposed riprap.

Volume = Width x Height x Length

V_1 = .60 x 4.00 m x 50 m. = 120 cu. m.

V_2 = $\left(\frac{1.40}{2} \times 4.00\right)$ x 50 m. = 140 cu. m.

Total volume.............. = 260 cu. m.

2. Refer to Table 2-12. Using Class B stone and Class C grout mixture, multiply

Cement : 260 x 1.214 = 315.64 say 316 bags.
Sand : 260 x .135 = 35.1 cubic meters

3. Length of the riprap divided by the weep holes at 2.00 meters spacing distance;

$\frac{50.00\text{ m.}}{2.00}$ = 25 pieces 3" dia. pipe at 2.00 m. spacing

4. For 2 layers weep hole, add 25 pieces 3" at 1.00 m.

   Total: 25 pcs. 3" diameter at 1.50 m. long.
   25 pcs. 3" diameter at 1.00 m. long

5. Find the volume of the granular soil (gravel) filter.

   V = .30 x .30 x 50.00 m.
   V = 4.5 say 5 cubic meters

6. Summary of the materials

   260 cubic meters Class B stone
   316 bags Portland cement
   35 cubic meters sand
   5 cubic meters gravel
   21 pieces 3" x 3.00 m. PVc pipe

7. For back filling, add 20% to volume for compaction.

2-10 CONCRETE RETAINING WALL

An existing stable earth slope can experience significant movement called slope failure or landslide due to changes in its natural condition or man-induced changes. There are instances where the materials in cut banks slip down to the roadway or carrying portion of the shoulder of the road. This pattern of failure is common in fills or cut slopes of homogenous non-granular materials.

ILLUSTRATION 2-15

A gravity wall 50 meters long has the following dimensions as shown in figure 2-24, list down the materials required using class A concrete.

SOLUTION

1. Find the volume of stem.

V = (.15 + .30) x 4.00 x 50.00 = 90 cu. m.

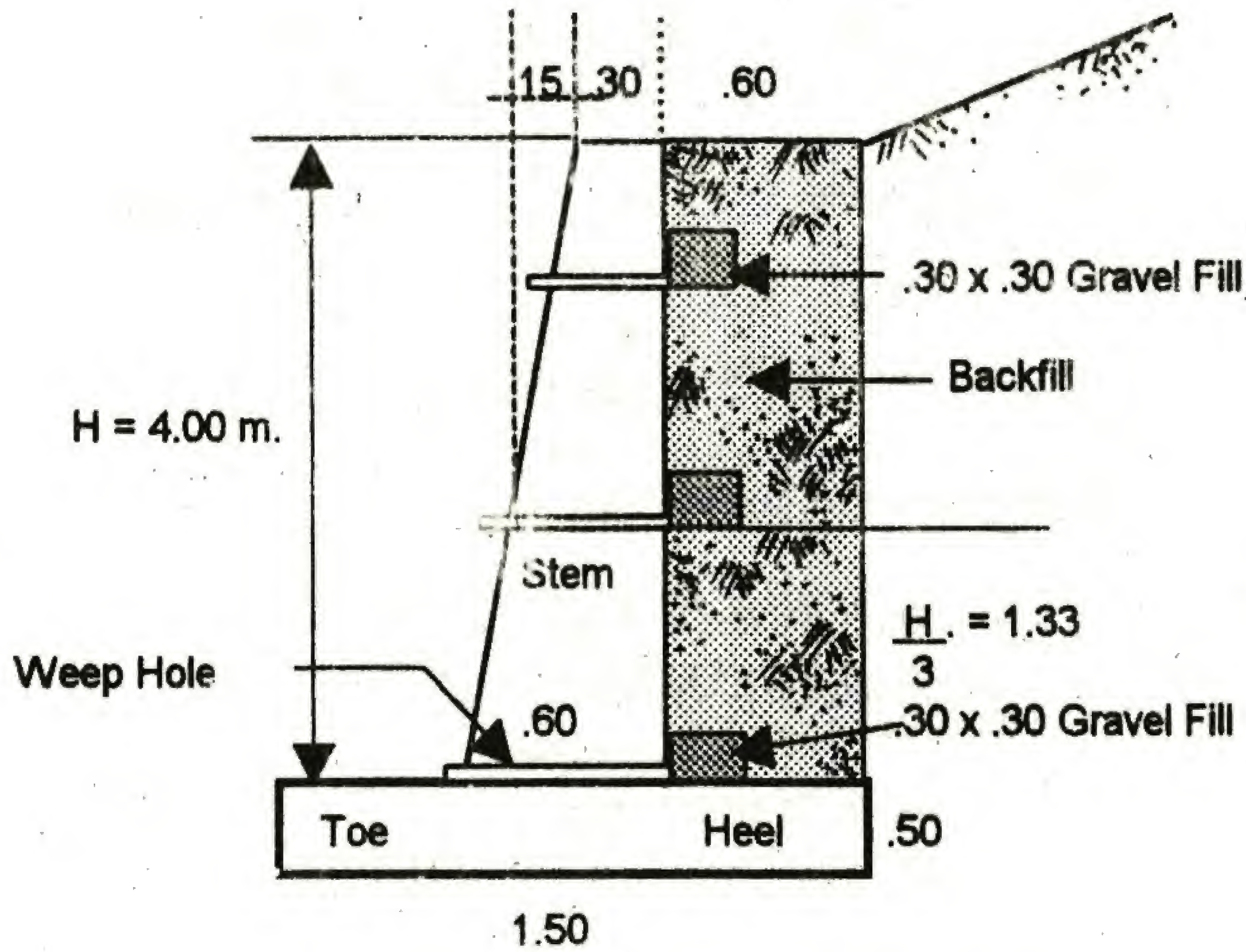


FIGURE 2-24 CROSS SECTION OF RETAINING WALL

2. Find the volume of the footing.

   V = .50 x 1.50 x 50.00 = 37.5 cu. m.

3. Total volume of 1 and 2.

   V = 90 + 37.5 = 127.5 cubic meters

4. Refer to Table 1-2. Using class A mixture, multiply:

Cement:	127.5	x	9.0	=	1,148 bags
Sand:	127.5	x	.50	=	64 cu. m.
Gravel:	127.5	x	1.0	=	128 cu. m.

5. For Reinforcement, see plan and refer to Chapter-3

6. For Weep Hole pipe, divide length by 2.00 meters.

   $\frac{50.00}{2}$ = 25 pieces at .60 m. 1st layer

25 pieces at .50 m. 2^{nd} layer
25 pieces at .40 m. 3^{rd} layer

7. Find the volume of Gravel Filter Filler:

$$V = .30 \times .30 \times 50 \text{ m.} \times 3 \text{ layers} = 13.5 \text{ cubic meters}$$

8. Find the volume of backfill materials.

$$V = .60 \times 4.00 \times 50.00 = 120 \text{ cubic meters}$$

8. Add 20% for compaction; 120 + 24 = 144 cu. m

10. Summary of the Materials

1148 bags cement
64 cu. m. sand
128 cu. m. gravel
7 pcs. 3" x 6.00 Pvc pipe
14 cu. m. gravel
144 cu. m. back fill materials.

2-11 GABIONS AND MATTRESS

Gabions and Mattresses are used to give permanent protection and support to sea walls, river banks , culverts, reservoirs, road bridges and many other structures in civil engineering works. Gabions are box shaped containers made of tough woven hexagonal netting strengthened by selvedges of heavier wires. To further strengthen the container, diaphragms are added to divide the gabion into 1 m compartments

Recommended Uses

When filled with quarried stone on site, Gabions and Mattresses prove to be excellent materials for construction of retaining and anti-erosion structures. Major applications include:

1. Slope stabilization for embankment and cutting
2. Prevention of erosion in river embankments.